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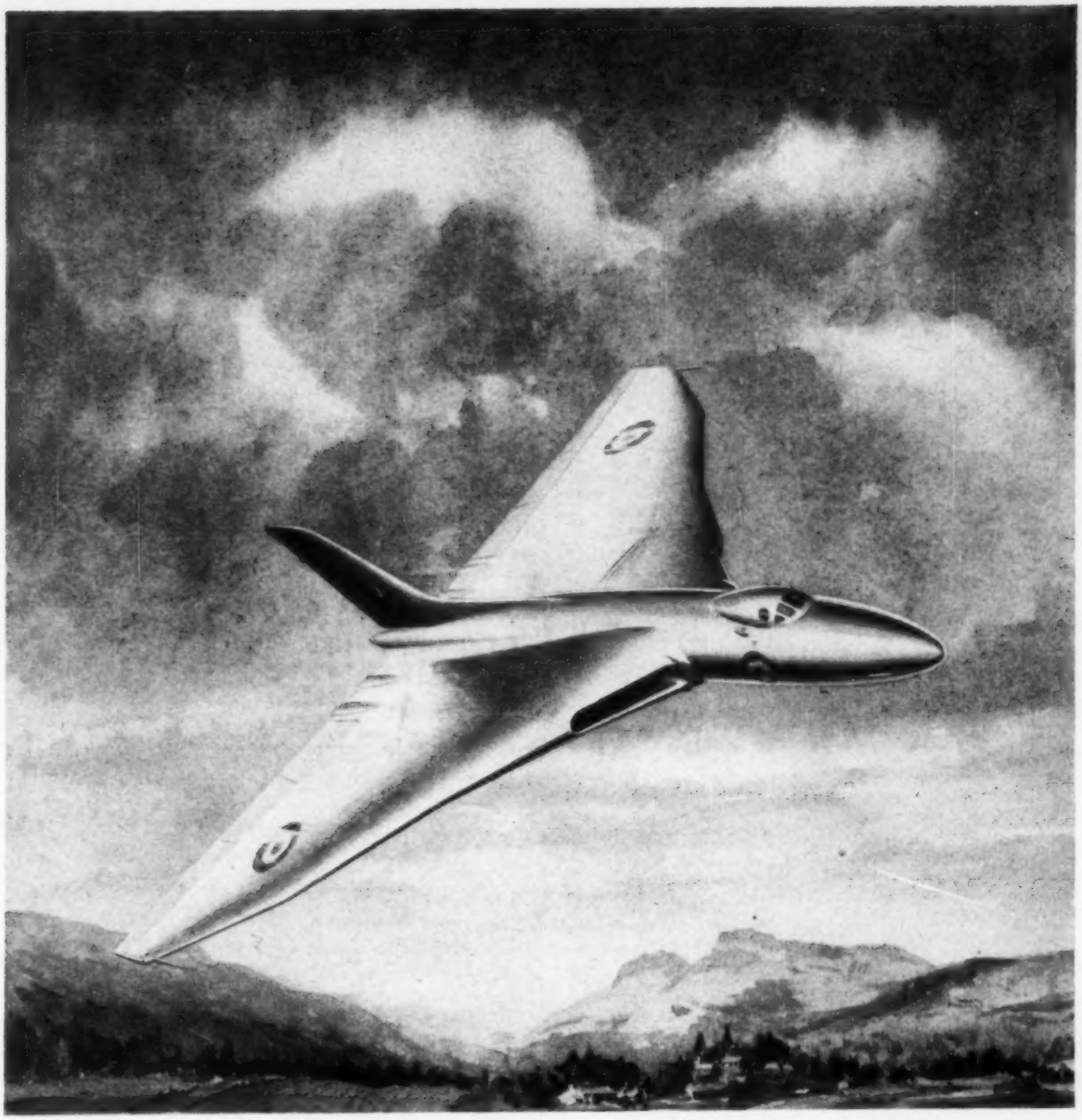
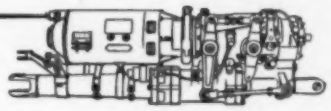


Avro Vulcan



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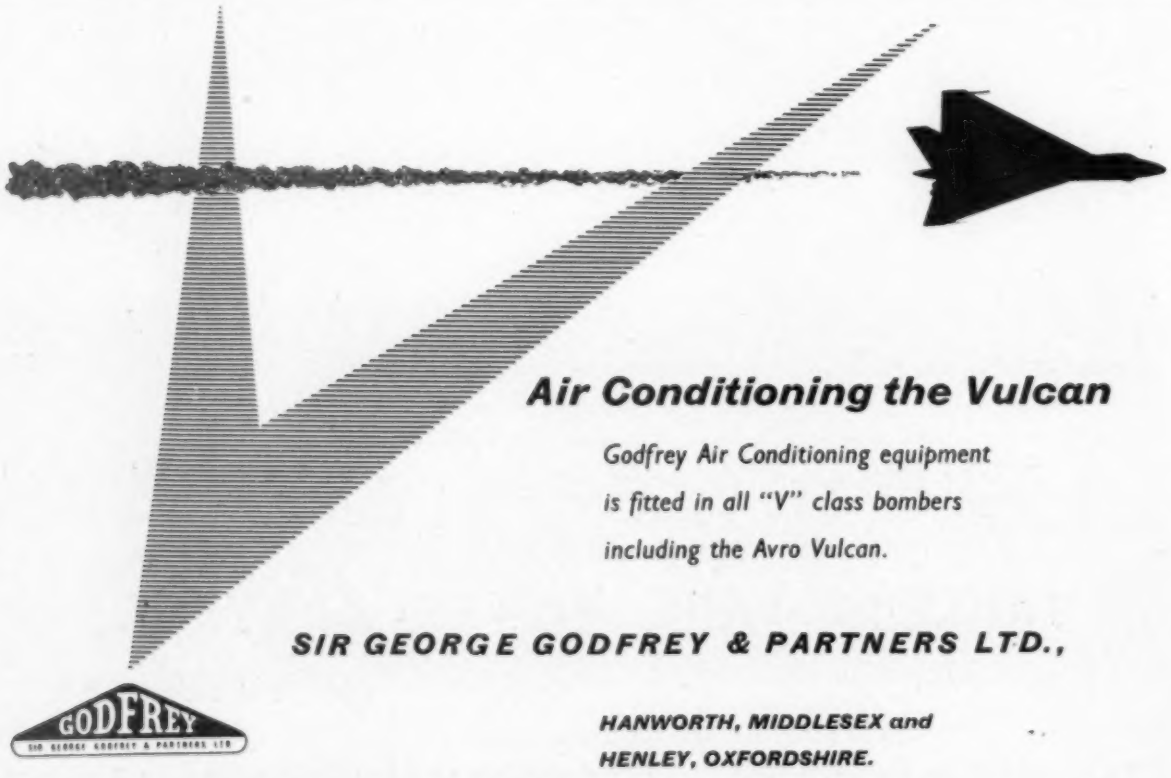
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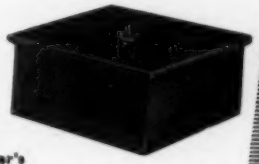

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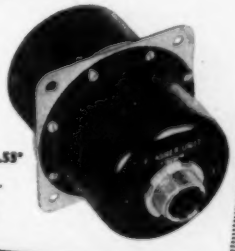

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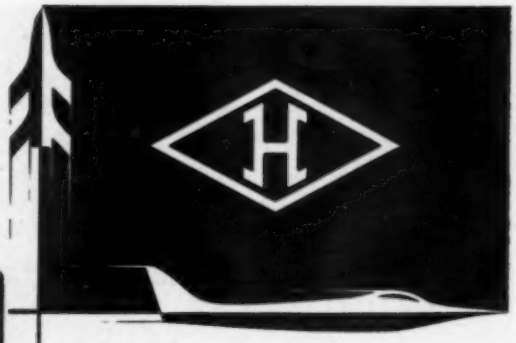

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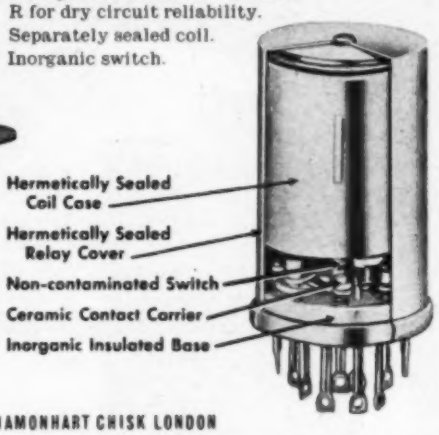

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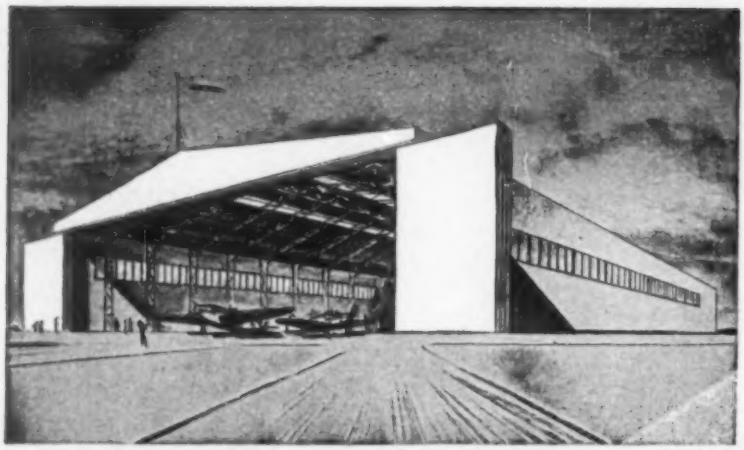

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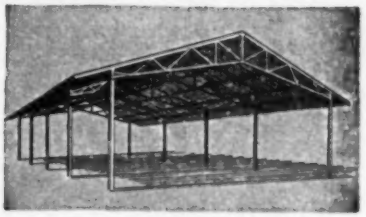

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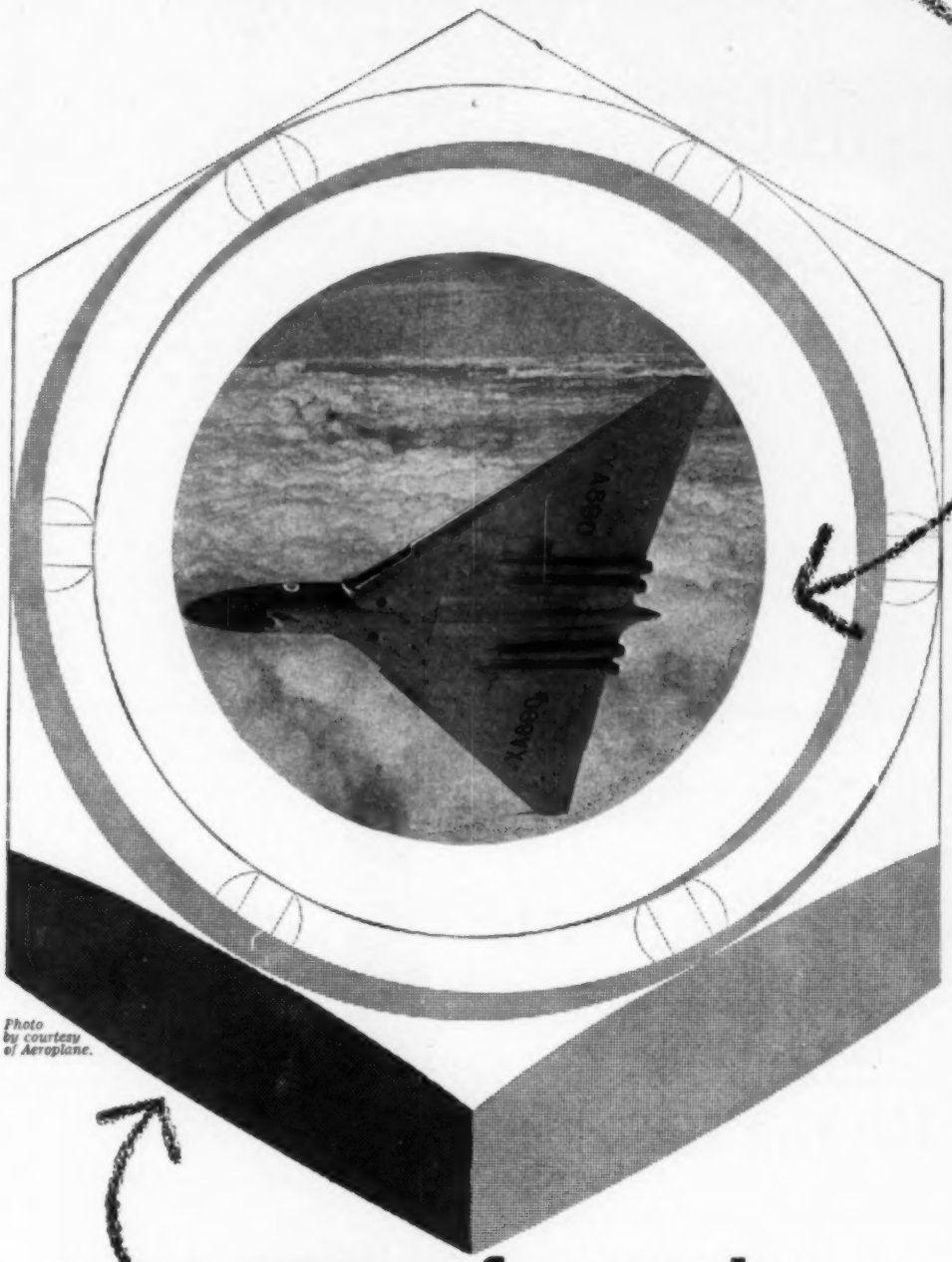

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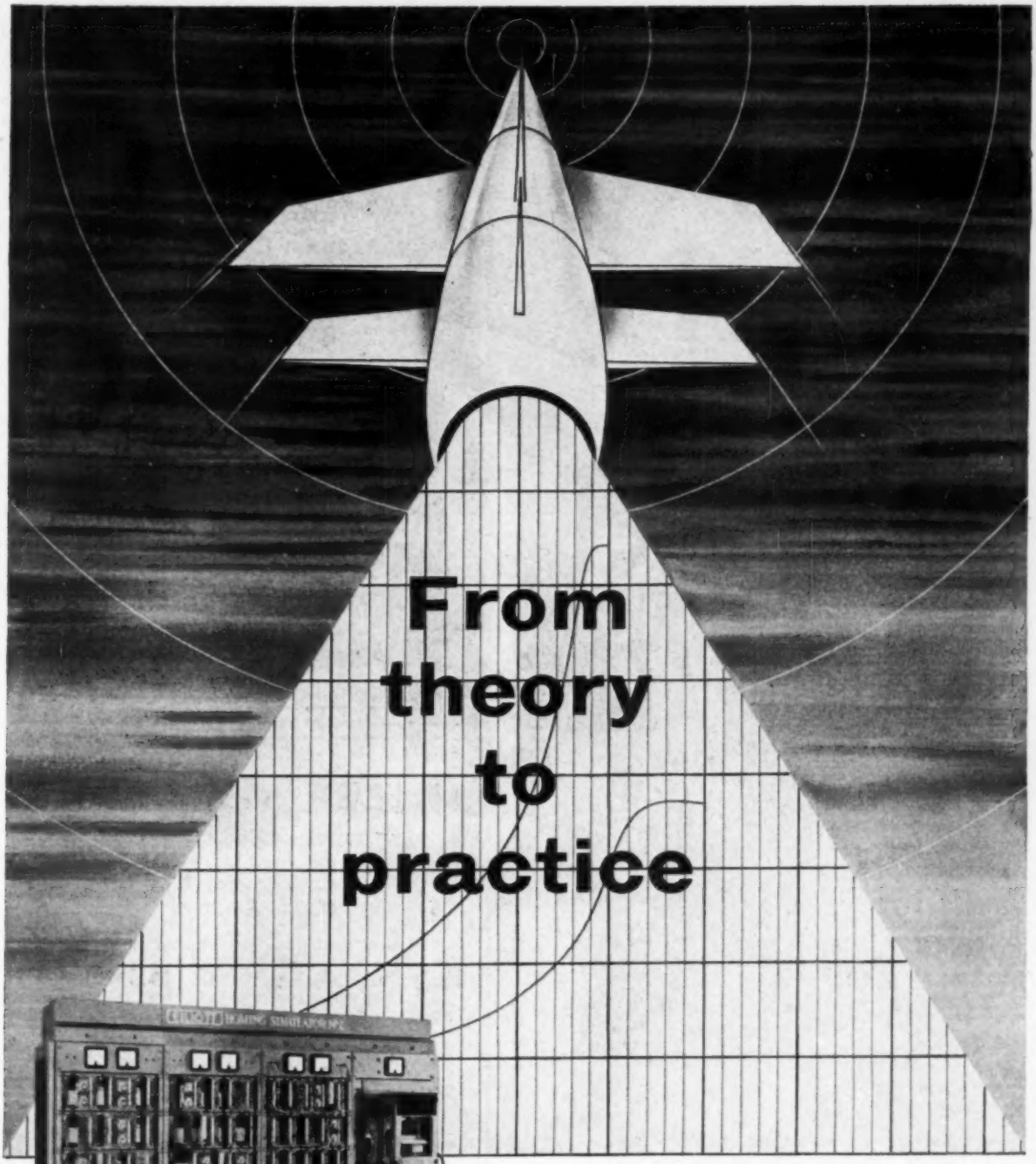
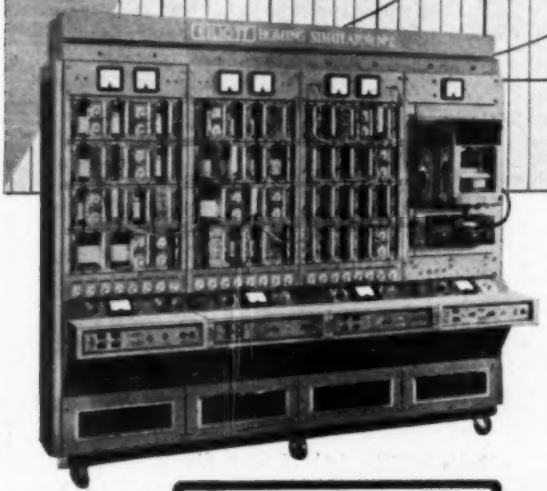


From theory to practice



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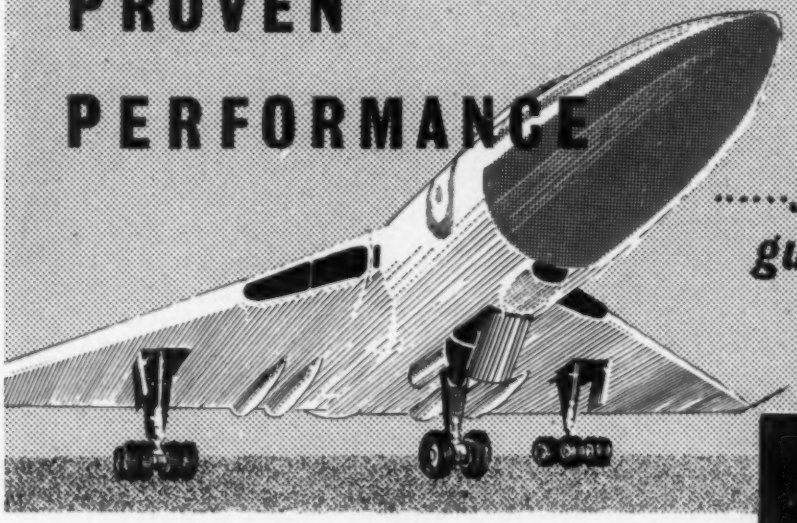

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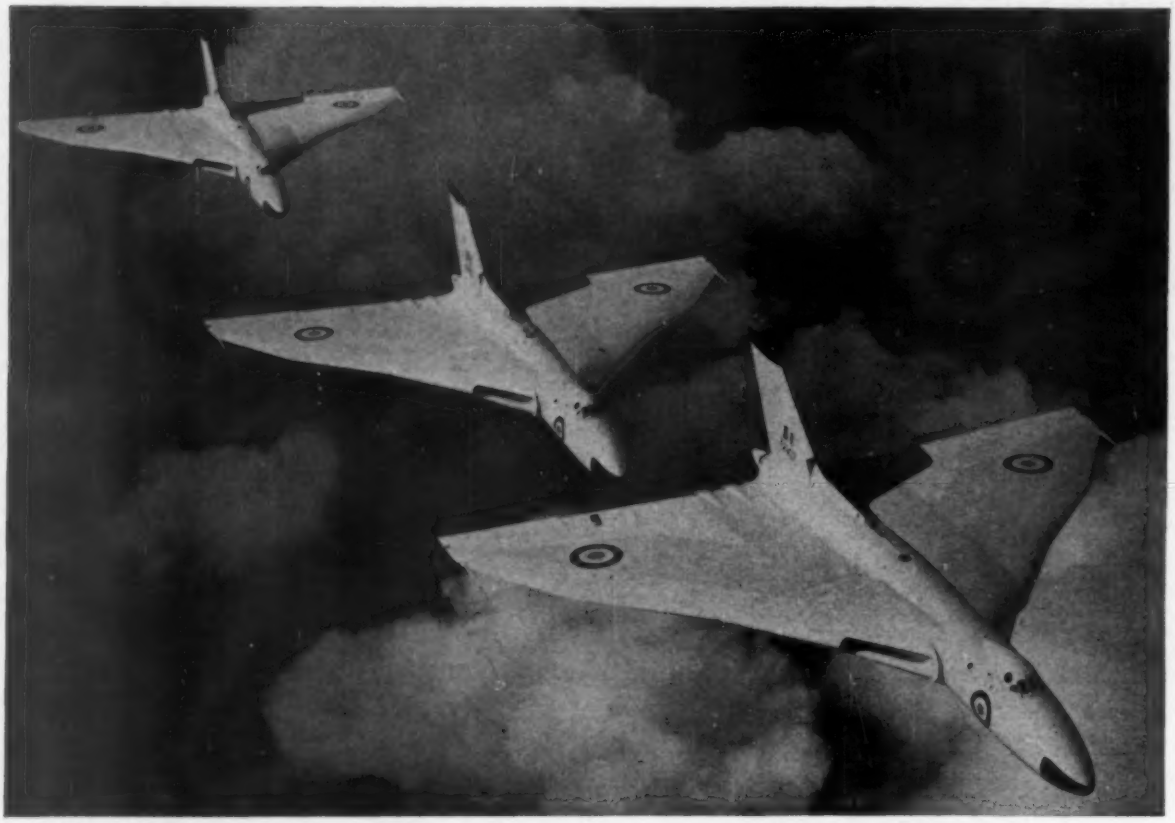

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In announcing that the famous 617 Squadron—the Dam Busters—is to be reformed and equipped with the Avro Vulcan Delta Bomber, believed to be the fastest bomber in service anywhere, Mr. Charles Ian Orr-Ewing, Under Secretary for Air, has said that in the Vulcan "we now have a bomber aircraft which is equal to, if not better than, anything else in the world".

"The Vulcan comes from a good stable"

In addition to Mr. Orr-Ewing's tribute, the Air Officer Commanding No. 1 Group, Bomber Command, had this to say: "We are extremely pleased with the Vulcan, both from the operating and the maintenance aspects. The way in which this large aircraft and its complex system has been brought into use in the front line of Bomber Command, without any of the enforced groundings so frequently experienced with new types of aircraft, is most gratifying. The Vulcan is giving us splendid utilization; indeed, it is far better than we experienced with any other type of aircraft, large or small. The Vulcan comes from a good stable and is liked by the servicing crews as well as the flying crews."

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FLIGHT
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AIRCRAFT ENGINEER

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Editor
H. F. KING M.B.E.

Technical Editor
W. T. GUNSTON

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Fees for Experience

THE ill wind that has halted the B.E.A. jet negotiations in an acrimonious flurry has also blown somebody a certain amount of good; for the impasse has allowed the public, the industry and the Government to take a good long look into matters of mutual concern.

Though chided for its tardy planning, the Government, in important respects, has made its attitude austerely plain. The Minister of Supply affirms that customer-requirements must not be satisfied in a way which might involve financial liabilities on his department, or throw on his establishments a load of work that could well be performed by private facilities. And he declares that military contracts will go to firms that are in the civil field also.

All along there has been much goodwill towards the de Havilland pioneers in their fight to guard the future of their workers, and to exploit their matchless experience in building and operating jet airliners; and it was right that this experience—won out of bitter adversity—should have been recognized by B.E.A. in their choice of the D.H.121.

It has been asserted that technical competence represents a mere 20 per cent of a successful transport aeroplane, the other 80 per cent being commercial *savoir faire*—or, as we have called it, experience. Such assessments are difficult either to support or refute, but they can at least be put to the touchstone of reality. Thus, while on the one hand there is the tangible fact of de Havilland's experience, there is, on the other, Hawker Siddeley's exemplary introduction into service of the Vulcan—a feat which, allied with Bristol's commercial eminence, set a lustrous warrant on the Bristol 200 from the outset. (As for the Boeing 707—the most heavily ordered jet-liner in the world—its "commercial *savoir faire*" amounts not to 80 per cent but to an insubstantial figure represented by a few elderly piston-engined Stratocruisers!)

It has been said that experience is a good school, but that the fees are high. De Havilland have certainly paid their fees in full, and though any balance outstanding on Hawker Siddeley's own account promises to be made good by the opening of a joint account with Bristol, this businesslike move is still far from certain, as this is written, to achieve its end.

Kind Home Wanted

IT is sometimes said that the British are a people so attached to the archaic that they let sentiment impede progress. Certainly it is true that we are given to tossing our treasures on the scrap-heap and later—usually a good many years later—regretting it. Though the objects our fathers kept about them may be only curiosities to us, to our own descendants they will be of intense interest and educational value. This is as true of aeroplanes as of any other kind of vehicle, or of buildings, or of pieces of furniture.

For that reason *Flight* has been gladly according space to a succession of letters from readers seriously interested in the history of aeronautics and, more specifically, in historic heavier-than-air craft. On page 161, in a masterly synthesis of the rather diffuse views so far expressed, J. M. Bruce (whose articles on World War I aircraft themselves establish his authority to act as spokesman) makes it clear that there is a very real need for some tangible means—i.e., the formation of a society or association—of bringing this interest to a focus.

Here, *Flight* feels, is an opportunity for some existing organization to extend a friendly hand. Ideally, this would be the Royal Aeronautical Society, if only for the reason that its own history goes back 92 years, that it has already shown enterprise in acquiring the Nash Collection of veteran aircraft, and that accumulated in its archives is an incomparable store of aviation history.

Delivered by such a respected midwife, the infant association could hardly fail to thrive; its progress might even attract the benevolent attention of godparents (the industry?) in a position to assure its future; and if on reaching maturity it were to beget the oft-discussed national aeronautical museum such guardianship would be more than justified.

FROM ALL QUARTERS

P.1 German Demonstration

TWO West German Air Force pilots, Col. Albert Werner and Capt. Hans Knierer, were flown to Warton by Canberra last Monday to evaluate the P.1. These tests, according to West German Defence Ministry sources, were being carried out at the "urgent wish" of the English Electric Co.—and reliable sources in Bonn last week-end said this implied that the P.1 was again under consideration as a Luftwaffe intercepter. But the same sources added that its chances were "small" compared with those of the Lockheed F-104 Starfighter, Grumman 98J Super Tiger and Dassault Mirage III—the Defence Ministry having said recently that it was no longer interested in buying the P.1.

Another contender has now entered the German intercepter field, Sweden having offered the Saab Draken 35. So far, however, the West German Defence Ministry has only compared technical data on the various machines.

According to *Aviation Daily*, Grumman are stated to have made "a new bid to interest the German Air Force in ordering the F11F-1" Super Tiger by offering a version powered with a single Rolls-Royce RA.24 Avon. The thrust of this engine is given as 10,500 lb, which is 750 lb less than the published Rolls-Royce figure. The *Daily* goes on to say that the RA.24 would be a temporary installation, and that at a later date the German Air Force could substitute the Rolls-Royce RB.133. The latter is reported to be "a new engine currently in the development stage." The normal powerplant of the Grumman Model 98J, or F11F-1F, is the General Electric J79.

As we go to press there is no further news of the three other American aircraft which have previously been named as contenders for the German order: the Republic F-105 Thunderchief, the Chance Vought F8U-2 Crusader (or F8U-3) and the Northrop N.156. The latter, being a fighter derivative of a light supersonic trainer which has yet to fly, is least advanced in development. The pipe-line for F8Us will be well filled for several years by heavy U.S. Navy and Marine Corps orders, which increased by $300m since December. The F-105—which can take a British engine, such as the Olympus 200, Conway or Gyron—is to enter U.S.A.F. service within 60 days, and is available with several interchangeable noses to fit it for a variety of missions.

1957 R.Ae.C. Awards

FOR "the most outstanding aeronautical achievement of the year" the Britannia trophy has been awarded for 1957 to Michael Randrup, chief test pilot of D. Napier and Son, Ltd., and Walter Shirley, deputy chief engineer, who set up a new world height record for aeroplanes (70,310ft) in a Scorpion test-bed Canberra on August 28.

The Royal Aero Club has also announced the award of the de Havilland trophy—for the best time in a record or race—to G/C. John Cunningham, chief test pilot of the de Havilland Aircraft Co., Ltd., for his London-Khartoum flight in a Comet 3 on October 16 at an average speed of 523 m.p.h.

R.Ae.C. Silver Medals have been awarded to W/C. C. E. F. Arthur, C.F.I. of Fair Oaks Aero Club, on completion of 40 years' flying; to Lt-Col. A. J. Deane-Drummond, for a series of U.K. gliding records; and to Capt. E. E. Fresson, for 40 years' flying during which he was a pioneer of Scottish flying and ambulance services. An R.Ae.C. Bronze Medal has been awarded to Harry Harper for his work in aeronautical journalism from 1906 to the present time.

Vanguard Postponement

PREPARATIONS for the second attempt to launch the U.S. Vanguard satellite were postponed on Sunday last following a series of mechanical faults. The difficulties at Cape Canaveral were accentuated by bad weather, and it was reported that at least four attempts to launch the rocket had been planned, and cancelled at the last minute, between January 22 and January 26.

Record Export Year

EXPORTS for the U.K. aircraft industry in 1957 reached a record value of £116.5m, well in excess of the previous record set at £104.5m in 1956. A break-down of last year's figures shows aircraft and parts contributed £69.8m; engines, £40.6m; tyres £0.8m; electrical appliances £3.3m and instruments £2.0m. With the exception of aircraft and parts, all categories showed substantial increases over the previous year. India headed the list of customers for aircraft and parts, having spent £11m in the U.K. Other leading purchasers were the Netherlands, £6.0m; Sweden, £5.6m; U.S.A., £5.1m; Canada, £3.9m; France £3.1m; and Israel, £3.0m.

Last December's exports were a record for any month, amounting to £17.5m. This figure included two further record monthly totals—£12.6m for aircraft and spares (of which £4.8m went to India) and £4.4m for engines.

Viscount 700s Grounded

SOMETIMES—as happened with 21 of the earlier Viscounts last week-end—the experience upon which the continuous cycle of aircraft modification is based gets ahead of the modification programme. Fatigue testing on Viscount airframes has been in progress since January 1953, and limitation on the number of landings has been imposed as a result. It was considered that, provided the tension booms of the inner main spars on the first 24 Viscounts to be built were all changed by next summer, the safe life of the wing would not be exceeded, and further cycling of the first eight booms to be changed appeared to support this view. But a boom returned from Air France last week showed evidence on test of accelerated crack propagation where the lower skin is bolted through the boom, and Vickers and the A.R.B. decided to ground all Viscounts with old or unmodified spars—ten of B.E.A.'s 701s, nine Air France 708s and two Aer Lingus 707s, plus a further one already being modified.

The work involves replacing the lower booms with new booms of similar design. On subsequent aircraft to those now grounded for modification the number of skin-securing bolts in the boom

AHEAD OF SCHEDULE by over a month, the final Hawker Sea Hawk of the batch of 22 ordered by the Royal Netherlands Navy was handed over on January 23 at the Bitteswell factory of Sir W. G. Armstrong Whitworth Aircraft. At the informal ceremony were (l. to r.) Mr. K. H. Jeffery, M.o.S.; Cmdre. Leertouwer, R.N.N.; Mr. H. M. Woodhams, A.W.A. managing director; Lt. B. A. Benson, U.S.N.; and Captain C. W. T. van Boetselaer, Netherlands Naval Attaché in London.

AVRO APPRENTICES received recognition when the company's prize-giving took place at the Chadderton factory last Friday. In this group are (l. to r.) Geoffrey Tebay (winner of Roy Chadwick Memorial Award); William Chadwick (504 Trophy), Sir Roy Dobson, Avro managing director; and Derek Jackson (Freddie Bassett Trophy). In the foreground are the 504 Trophy (left) and Bassett Trophy. The total of apprentices in the Avro school ("Flight," December 26, 1952) is 746.

was reduced from four to two and the holes were bushed; but these modified booms cannot readily be incorporated, although a salvage scheme for the earlier booms might be introduced. Later, on the 90th and subsequent aircraft, the D.T.D. 363A high-strength alloy material of these early booms was changed for fatigue-resistant L.65 and the section sizes increased.

New booms will take about four weeks to incorporate, but will not seriously affect the various airlines' winter schedules. Air France said last Saturday that "they hoped to be back to normal in a few days" and Aer Lingus that they should suffer "little disruption of services." B.E.A., using Viscount 802s, DC-3s and Elizabethans, hope to cancel none of their flights.

RJTV Altitude Performance

FOR several years D. Napier and Son, Ltd., have been responsible for the design and development of ramjet test vehicles, under contract to the National Gas Turbine Establishment (*Flight*, August 10, 1956). On January 23, the company were permitted to announce that one of their RJTV firings, accelerated by four pairs of wrap-round boost motors, reached a speed of Mach 2.3 during the course of its flight; after its fuel was exhausted at 70,000ft the round coasted to 114,000ft before being destroyed by the range-safety officer.

The RJTV concerned was the most recent of a large number manufactured at the company's Flight Development Establishment at Luton Airport, Beds, and it was fitted with a double-shock intake with a conical centre-body. Basic dimensions are: diameter, 18in; overall length, 20ft. All firings have taken place from the range at Aberporth.

Gnat Mobility

THE Gnat Mk 1 which was shown in our issue of January 24 being loaded into an I.A.F. Fairchild Packet arrived safely in India. It was closely followed by its wing and a consignment of spares in a second aircraft, which arrived on Thursday, January 23.

The Gnat was reassembled and test flown on the following day and last Sunday, January 26, it took part in the Independence Day fly-past over Delhi. Thus within one week this light fighter has been dismantled, ferried a quarter of the way round the world, reassembled and flown—an achievement which, say Follands, supports their claims of strategic mobility for the Gnat.

Mr. W. E. W. Petter, the company's managing director and chief engineer, who flew out on January 22 to take part in Gnat production discussions, was present at the fly-past. Folland's contract with the Indian Government is for 25 complete Gnat Mk 1 aircraft plus 15 sets of components. The Gnat will also be built under licence by Hindustan Aircraft, Ltd., of Bangalore, where tooling-up is already in progress.

Advice to the Industry

AT a meeting with representatives of the Confederation of Shipbuilding and Engineering Unions on January 22 the Minister of Supply, Mr. Aubrey Jones, said that as there were no Government orders available to make good the reduction in defence contracts the aircraft industry must concentrate increasingly on civil and export work, success in which would be determined by the efficiency with which the industry reorganized itself. The Government was doing what it could to help this reorganization; but it was also desirable that firms should diversify their activities so that their other work could cushion the fluctuations in aircraft requirements. Many firms were in fact doing so.

Memorial Service to Sir John Boothman

THE memorial service for Air Chief Marshal Sir John Boothman, who died on December 29, was held at Christ Church, Down Street, London, on Wednesday of last week. An address was given by Marshal of the R.A.F. Sir John Slessor, and among those present were Air Chief Marshal Sir Walter L. Dawson, representing the Air Council and the R.A.F.; Air Marshal Sir Geoffrey Tuttle, attending in a personal capacity and also representing Air Marshal C. E. Chilton; S/L. H. T. Murley, representing the Secretary of State for Air; and Lady Boyle, wife of the Chief of the Air Staff.

Among representatives and members of the Royal Aero Club who attended were Mr. S. Kenneth Davies (chairman), Col. R. L. Preston (secretary-general) and Mr. Maurice Imray. At the time of his death Sir John was vice-chairman of the club, chairman of its aviation committee and chairman of its business aircraft users' committee. He had been a member of the club since 1923, having taken up private flying shortly after the first world war. Shortly after his Schneider Trophy win in 1931 he became a member of the R.Ae.C. racing and records committee, of which he was chairman from 1946 to 1948. He was a member of the main committee of the club from 1946 to 1949, and again from 1952 until his death. He had been vice-chairman of the club since 1953.

FORCED DRAUGHT: Now under development for the U.S. Army, the Fairchild M-224-1 VTOL has a fixed wing carrying large flaps on both front and rear edges, as well as four propellers geared to a central turboprop. The prototype should fly late this year.

Field-Bendix Co-operation

IT was announced last Monday that the Bendix Aviation Corporation, U.S.A., had appointed Field Aircraft Services, Ltd., as its general sales and servicing representatives in the United Kingdom. The agency covers an extensive range of Bendix products, including radar and radio equipment, instrumentation, and airframe and engine accessories. Fields (who are a company of the Hunting-Clan organization) expect that their "radar and radio centre" at London Airport, at present being re-equipped, will be in use by the end of February, and the Bendix servicing effort will also be supported by other Field units, i.e., the servicing division at L.A.P., the engine division at Croydon, the aircraft division at Nottingham and the instrument section at Bovingdon.

Elliott Brothers (London), Ltd., who have maintained a department for sales and servicing of Bendix aviation and radio equipment, announce that they have discontinued this particular activity and will concentrate on the sales, servicing and manufacture under licence of Bendix-designed equipment in this country.

Au Revoir Accountant

ON January 10, the Aviation Traders (Engineering) Accountant took off on what may have been its last flight—at least for a considerable time. On that day, after some 50 hours' flying since the first flight on July 9, 1957, this brave project virtually came to an end. The Accountant has been mothballed at Southend, Aviation Traders having given up a valiant struggle to find a manufacturer to take over the project and bring it to fruition. The company have not the resources to continue the work alone; and, with no hope of Government backing if things went wrong, there were no industry takers. Aviation Traders had asked only to cover their development costs (plus, they hoped, a small profit) after 200 or 300 production aircraft had been sold.

Many will say "I told you so" about the failure to obtain industry backing; the difficulties of a small company competing in the DC-3 replacement market; and the impossibility of selling an aircraft with no delivery date. Yet others will sorrow that such enterprise has not succeeded, for the Accountant was well timed and attracted a great deal of airline and executive interest. Rolls-Royce provided help with the Darts, and the airframe showed promise of exceptional life.

Designed by Mr. Toby Heal, the originator of "tensioned skin" construction, the aircraft gave the impression that, whatever design compromises had been made, structural simplicity had not been allowed to suffer. This resulted in a certain ungainliness from some angles (more particularly upon the ground) and it is interesting—if morbid—to speculate on the sales resistance this aroused. The tensioned-skin construction of the prototype fuselage and tail may also have raised production problems. When Mr. Heal left Aviation Traders in April last year, there were second thoughts about proceeding with this technique, and a more conventional fuselage was envisaged. Tests on the wing joints, for example, had shown that an "infinite life" might have been obtained, but the tensioned-skin fuselage would have had to be subjected to extensive tank tests. Two more centre-sections and a further set of wings were built, but at that point manufacture ceased and some staff had to be laid off.

Aviation Traders (Engineering) still hope that the industry will change its mind; meanwhile, Mr. F. A. Laker, director of the company, is in discussion with manufacturers who might offer production facilities in Germany and Japan. Modification of ex-R.A.F. Prentices continues; ten aircraft are now being converted to civil versions at Southend.

Local-service Viscount

A V.745 Development for the Short-haul Airlines

THE trunk airlines' round of jet and turboprop buying has brought in its wake new equipment problems and opportunities for their smaller brothers, the local-service lines. Most of these carriers still rely predominantly upon the DC-3, very large numbers of which are still in service. But the DC-3 cannot be expected to offer profitable capacity for very much longer, and already (in spite of some initial resistance by America's C.A.B., particularly to the import of aircraft from abroad) the local-service lines are turning to more modern equipment—piston-engined Convairs and turboprop Friendships (35 of which are on order by local lines) and so on for their new fleets.

But desirable as modern equipment may be (relegated aeroplanes, like passed-on clothing, do little to engender commercial self-respect) a lot of second-hand equipment is going to be offered to the local-service carriers as a result of trunk lines' buying. And on a capacity-for-money basis, there are likely to be some tempting bargains for the short-haul operator—relatively new DC-6s, some Constellations, and sufficient Convairs (notably 240s and 340s) to replace, on a capacity basis, the entire U.S. short-haul fleet.

It seems apparent that most local airlines are biding their time before starting their own round of re-equipment buying. As each year passes, the trunk carriers' need to sell will become more acute, and the purchasing price—as the market becomes flooded—will progressively be forced down. But the present reluctance to purchase is based not only on the short-haul operators' wait-and-see game, but on a real reluctance to buy what, by 1960, may be commercially uncompetitive equipment. The turbine revolution has been very widespread and, like everyone else, the local airlines want to offer turbine travel. So far, Piedmont Aviation, of North Carolina, are the only carriers to have plumped (with an order for twelve F-27 Friendships) for this on any scale, but others are likely to follow suit.

Of the second-hand equipment being offered, only the Convair is an attractive proposition on the "whistle-stop" type of service. The average passenger haul has been gradually decreasing and some stages are of less than 60 miles. DC-6s and Constellations, however cheaply obtained, offer too much capacity in one package for services of reasonable frequency to be flown. It is not only the rail and long-distance bus traffic that these carriers hope to attract, but also the motor-car traffic from the roads.

At the other end of the scale, there is a tendency—shown in a round of C.A.B. route-cases last year—for the local lines to take over some longer feeder-service routes from the domestic trunk carriers, who have been losing money on these sectors. The award to North Central Airlines of a new route from Duluth to Omaha dropped by Braniff International Airways, and the additional routes granted to Ozark Air Lines are good examples of the trend. Few trunk carriers can suppress their overhead costs enough to make money on local routes. Longer routes are extremely valuable to local operators, but pose further re-equipment problems. Many operators also require an aircraft that is suitable for occasional charter flights of 900 miles or more, yet can be easily serviced at minor aerodromes by "two men and a boy."

Although all of the U.S. local-service carriers are subsidized, they are very sensitive about the assistance for which they must appeal. Many operate on an economic knife-edge, and pare their overhead costs by the most stringent checks on every phase of their operations. Several operators (Trans-Texas Airways are a particular example) have a research engineer whose major responsibility is to devise ways of reducing engineering costs; at minor airfields the same man may well be responsible for ticketing, baggage, and aircraft servicing, and every carrier is aware of the value of good advertising and attractive paint schemes (after the style of the trunk carriers) in selling seats. It really matters to a northern local operator that in the winter his DC-3s have to be warmed up for 30 min where a turbine engine would be ready for an immediate start.

So keenly do the short-haul carriers regard a reputation established through regularity of operation that some appoint a vice-president of research to find cheaper ways of flying and arriving on time. They may, for example, fly under the airways to keep their service open when competitive trunk carriers' operations are halted by bad weather. All carriers do a good deal of this operational undercutting and devote much thought to such operational problems. Full radio equipment, sometimes exceeding the amount installed by the trunk lines, is consequently specified by most carriers. Nose radar is regarded as a particularly useful appendage for operations at low levels and in low minima.

What equipment do the local airlines *really* want to replace their DC-3s? For some, the Dart-powered Friendship may supply the answer. The initial cost (about $650,000) is within range of carriers who must always take a second or a third look at their budgets before they commit themselves, the Rolls-Royce engines are recognized to be the acme of turbine reliability, and the aircraft is of a size which—if there is any such animal anywhere—is generally accepted as being the likely DC-3 replacement. But the F-27 is not for everybody. In southern latitudes the high wing may provide shade and a good view for the passengers over scenic routes, but snow on the wings can prove a winter handicap in the north. Carriers who operate over water or coastal routes may prefer the additional safety of a low wing and some may require more freight space than the F-27 can offer. And with the boisterous growth of local service traffic there is a basis for some carriers contemplating larger aircraft.

Both larger and smaller aircraft are required. In the latter category, the Grumman Gulfstream is being watched with interest. Forward-looking engineering vice-presidents of local-service com-

All local service Viscounts will have airsteps as standard equipment. This is an example of the arrangement, on one of Capital's V.745s—the C.A.A.-certificated "Americanized" version of the Viscount 700 series.

panies have also evinced an interest in the Rotodyne. In the heavier category, the Eland Convair conversion offers a turbine engine for an airframe that should soon be available second-hand in appreciable numbers. And this week comes the news that Vickers-Armstrongs, as a result of a careful survey of this market, are offering a new version of the Viscount for intense operations over short hauls. The Viscount 790 is a logical development of the type 744 and 745 operated by Capital Airlines in this type of operation, and it embodies much of the design, manufacturing and operational knowhow gained by Vickers with the 700, 800 and 810 series aircraft.

It is not very difficult to define the operating parameters for the local-service type of aircraft. Short stages will be flown at low altitudes, into relatively small airports. Turn-round time is at a premium. Frequent landings will be made, utilization will be kept high, and the maximum number of seats must be put into the available cabin space.

An important decision was the choice of Dart Mk 506 powerplants of 1,400 s.h.p. Not the most developed of the Dart series, they have the immediate advantage of an established overhaul life in North America of over 1,400 hr. The take-off performance is good and, because smaller quantities of water-methanol are required, the installed weight is less than the powerplants in, say, a Viscount 800. In comparison with the Dart 510, into which water-methanol is injected at all temperatures above I.S.A., the 506

SPECIMEN VISCOUNT 790 ROUTE ANALYSIS SUMMARY

	Memphis–Pine Bluff	Pine Bluff–Hot Springs	Hot Springs–Tyler	Tyler–Dallas
Distance (nm)	131	80	192	100
Cruise altitude (ft) ...	8,000	6,000	10,000	6,000
Flight time (min) ...	35	22½	51	26½
Payload (lb)	8,980	10,220	11,660	11,660
Passengers	47	53	56	56
Take-off Run Required (ft)	5,180	4,950	4,930	4,400
Landing Run Required (ft)	5,050	5,000	4,800	4,600
Payload limit	Land Wt(CAR)	Land Wt(CAR)	Capacity	Capacity

Assumptions: All ground temperatures are taken to be 90 deg F, and air temperatures I.S.A. +15 deg C. No refuelling is done at intermediate stops and allowances are made for an additional 20 n.m. on all sectors for A.T.C., a 10kt headwind, normal ground fuel plus idling consumption, and a final reserve of two hours at 5,000ft. Runway lengths are: Memphis, 8,927ft; Pine Bluff, 5,100ft; Hot Springs, 5,000ft; Tyler, 5,100ft; Dallas, 7,750ft.

does not require injection below I.S.A. + 10 deg C. Rotol paddle-blade propellers with an activity factor of 140 and a higher engine : propeller gear ratio are additional aids to good take-off performance. (Activity factor is the integrated blade width—"solidity"—of the active portion of a propeller blade factored for convenience in calculation to give an answer between about 50 and 250 per blade.)

The choice of fuselage was limited by considerations of weight. An 800-series fuselage, although providing additional capacity, would have increased the take-off weight to an unacceptable value. Because stages are short, no galley is required, and only one toilet is provided. Provision is made, however, for the installation of a carry-on luggage rack and for a "coffee and light refreshments" cupboard.

Two separate accommodation layouts are offered. The standard layout provides four-abreast seating for 54 passengers at a pitch of 34in and a revised geometry—similar to that used on the 800 series—permitting increased cabin width. An alternative five-abreast arrangement provides additional seats. These layouts include a freight hold below the floor forward of the wing and another above it immediately in front of the pressure bulkhead; the total capacity is about 300 cu ft. If the rear upper freight hold is used for additional seats, 60 passengers can be carried four-abreast or more again with the five abreast arrangement. Weight-saving has been achieved by deleting the rear freight door, fuel dumping, the autopilot, flight system and auto-synchronizing of the propellers (manual adjustment is still fitted) but against this all 790 Viscounts will be equipped with hydraulically operated airsteps (weighing 250 lb) as an essential adjunct to rapid turn-around at minor airports.

The Viscount 790 will be equipped with a specially robust undercarriage for local-service operations, and will have controlled-orifice shock-absorbing and steel-ceramic plate brakes as used on the V.810.

The aggregate effect of these changes has been to reduce the manufacturer's empty weight of the V.790, complete with airsteps, to a figure comparable to that of the 40-seat V.770D (standard American aircraft) less airsteps. The normal zero fuel weight is about 1,000 lb higher than the V.770D and the maximum landing weight has been increased by a similar amount. The payload is capacity limited to 11,900 lb.

Measured against the 790's maximum take-off weight of 61,500 lb, the ratio of maximum landing weight (58,500 lb) to take-off weight is six per cent higher than that achieved with the 770D. This is an important asset to maximum payload operations on short stage-lengths where relatively little fuel is burnt before the first landing must be made. Compared with the V.770 again, there is an additional 1,500 lb (a total of 8,500 lb) available between the zero fuel and maximum landing weights to use as fuel load for continuous operation without refuelling on short stages.

Most of the remaining modifications that characterize the V.790 are concerned with ground handling and turn-around arrangements. After landing, the aircraft would be taxied in on the inner engines with the outers idling so that full cooling air and electric and hydraulic power would be available. Since most electric and hydraulic components would be worked harder, special attention has been paid to their reliability; hydraulic-pipe sizes, for example, have been increased. When the aircraft is on the ramp, both port engines and the starboard inner can be hydraulically braked to a stop but the outer starboard is left running; engine accessories have been regrouped so that this engine drives a generator and hydraulic pump to supply accessory power. Passengers can be loaded and unloaded through the forward door and hydraulically operated airsteps, and baggage through the belly hold doors; the rear freight door has been deleted.

With the starboard outer engine running, there are no problems in starting the remaining engine, but in any case a total of six batteries is fitted for self-contained starting if the outer engine has to be stopped. A starting trolley would normally be used after an overnight stop.

In judging the suitability of the Viscount for local service the limitations of so relatively large an aircraft must first be considered. At low altitudes, and temperatures of not more than I.S.A.+15 deg C, the aircraft can be operated at full load out of 5,000ft runways, or with reduced load from slightly shorter strips. The restriction is in landing runway length and "landing climb" rather than in take-off performance. The table given on this page, for a fairly typical local service sector from Memphis to Dallas, shows the V.790 route performance and the payload restriction encountered. The aircraft can, if necessary, operate into 4,300ft runways, but the number of passengers carried would be restricted to DC-3 level. The Viscount's *forte* is operation over the denser local service routes where the operator is in competition with (or an easy road journey away from) the modern equipment of trunk carriers.

Frequent landings impart high engineering costs to local operations; Vickers' studies suggest that the total engineering costs of airlines having average flight times of 30 min might be expected to be twice those of, say, Capital's in 1956, where the average flight time was about 1 hr 20 min. Other costs vary so sharply with individual operations that it is unrealistic to quote "typical" figures. A depreciation policy of amortizing the airframe to ten per cent of its original value after ten years might be assumed which, at 2,000 hr per year, gives virtually the same airframe life before write-off as a trunk-line aircraft after seven years.

There is no one aircraft that will replace every function fulfilled by the DC-3. New equipment for the local service operators will be chosen after study of a much wider market than has been available to them hitherto. The Viscount 790 is among the largest—and, at over $1m, certainly most expensive—aircraft on offer, but it has been carefully tailored to local service needs, and it can show attractive speed and economy of operation on routes where it is not over-hampered by airfield limitations. To an increasingly turbine-conscious world the Viscount 790 offers, not least, the appeal of a famous name.

A. T. P.

"It's a DC-3 replacement."

HERE AND THERE

RECOGNITION RECOGNIZED: Members of the Dutch team who (as recorded below) won four trophies in the Aircraft Recognition Society's contest, seen with Lt-Col. J. B. H. Bruinier, Netherlands Air Attaché (second from left), and Mr. Peter Masefield (centre) who as president of the Society presented the trophies. The team members are (left to right) Pvt. A. van Niekerk; Lt. J. Valette; and Sgt. W. Kroese.

Swiss Hunter Approval

ON January 21 the military committee of the Lower House of the Swiss Federal Parliament voted in favour of buying 100 Hawker Hunters, and it was expected that the House itself would give final consent to the purchase—which was agreed to by the Upper House last December.

High Society

A WOMAN lieutenant-colonel in the U.S. Civil Air Patrol, Miss Ruth Nichols, reached a height of 51,000ft on January 21 in a Convair TF-102. She claims to have broken the world's altitude "record" for women by 3,000ft.

Martin Research Director

APPOINTED director of research for the Martin Co., Dr. Albert C. Hall will be in charge of technical activities associated with the Titan ICBM project at Denver. Noted for his work on missile control and guidance systems, Dr. Hall has been associated with Bendix Aviation Corporation since 1950 and was previously at M.I.T., where he founded the dynamic analysis and control laboratory and did considerable research and development work on servomechanisms.

U.S.A.F. Leaving Manston

MAJOR U.S.A.F. operational and administrative units and personnel based at R.A.F. Station Manston are to be withdrawn by the middle of this year. Manston, which is equipped with Fido and has a 3,000 yd runway, is a master diversion airfield and the nearest R.A.F. base to the Continent. Air Ministry are considering its future use. U.S.A.F. units at present there include the H.Q. of No. 406 Fighter Intercepter Wing, Nos. 513 and 514 (Fighter Intercepter) Sqns. and No. 92 (Fighter Bomber) Sqn.

Lockheed Orpheus Order

A NEW order has been placed with Bristol Aero-Engines, Ltd., by the Lockheed Aircraft Corporation for Orpheus turbojets for the second prototype Jetstar, which it had been expected would be fitted with American engines. Last October, Lockheed announced that a twin-Orpheus version of the Jetstar would be offered for sale as an alternative to the four-engined version using American units of lesser power. Initially the Orpheus was fitted to bring forward the date of the Jetstar's first flight, which was made on September 4, 1957.

Airborne Washing Machines

A PILOT scheme for the export of 2,000 washing machines by truck-air services to Belgium, under a contract between the Rubery Owen Group and Sabena, started last Monday. Transport by air means that the goods arrive in Brussels 48 hours after leaving Wolverhampton, compared with 10 to 14 days by the land-sea route. Mr. Alfred Owen, chairman of Rubery Owen, said that the group was examining costs for a similar service to distributors in Germany, Austria and Scandinavia.

Dutch Recognition Success

FOUR trophies were won by the Royal Netherlands Air Force in the Aircraft Recognition Society's tenth annual all-England contest, held at the Royal Institution on January 18. The Dutch team gained the Silver Hurricane trophy, which is awarded to the outright winners of the contest and this year was taken abroad for the first time; it carried off the Viscount trophy (awarded to the best Services team competing); one of its members, Pvt. A. van Niekerk, won the Bristol Britannia trophy as the highest individual scorer—with 33 points out of a possible 35; and the team took back with it to Holland a Fokker D.21 trophy which had earlier been presented to the Society by the Dutch Chief of Air Staff, to be awarded to the Services competitor with the highest score—on this occasion Lt. J. Valette of the R.N.A.F. The H. P. Heracles trophy was won by No. 276 (Chelmsford) Sqn. of the A.T.C., who with 90 points out of 105 were only one point behind the Dutch team; and Cpl. C. M. Howlett of No. 276 Sqn. won the *Air Pictorial* trophy as the highest individual A.T.C. scorer. Mr. Peter Masefield, managing director of Bristol Aircraft, Ltd., who is president of the Recognition Society (and who donated the Britannia trophy), presented the awards; and earlier in the afternoon he received from Lt-Col. J. B. H. Bruinier, the Netherlands Air Attaché, the Fokker D.21 trophy presented by the Dutch C.A.S.

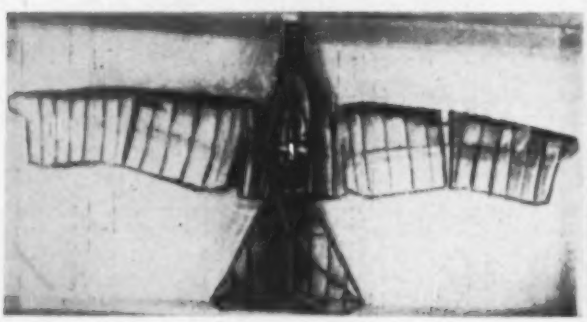
Moscow Flap

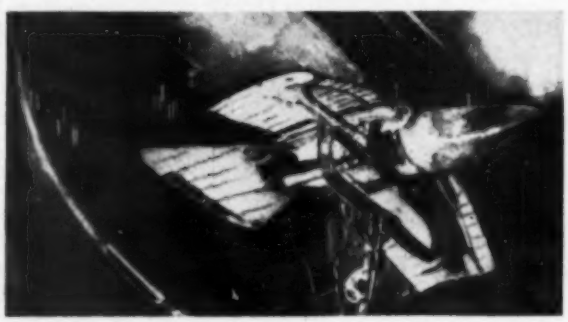
ORNITHOPTERS—flapping-wing aircraft—are occupying the attention of two Russian designers, according to a Moscow report. One, Smirnov, has modelled his wing-shape on that of a bird and the other, Rybnikov, has followed an insect pattern. Their research is being carried out under the ægis of the so-called "flapping wing flight committee" attached to D.O.S.A.A.F. (Voluntary Society for Co-operation with the Army, Air Force and Navy).

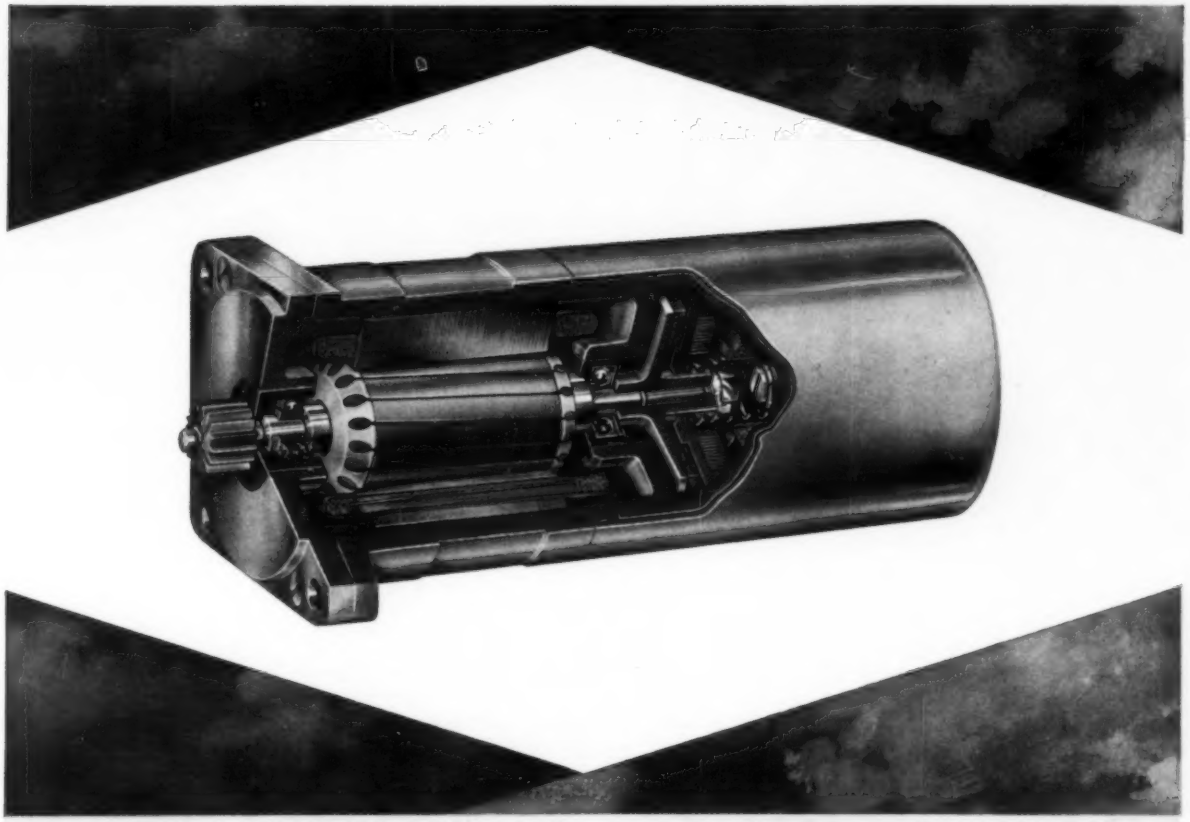
U.S.S.R. Hypersonics

IN a Moscow Radio broadcast Prof. Vladimir Pyshnow, described as an aerodynamics expert, said that in the near future Soviet engineers would be able to build aircraft capable of flying at Mach 5. Excellent turbojet and rocket engines suitable for this purpose and developing "hundreds of thousands of horse-power" were already in existence, Prof. Pyshnow claimed; and the problems of flight at hypersonic speeds were being studied.

RUSSIAN ORNITHOPTER models are seen in these pictures received by wire from a Soviet official source. The one on the right, said to be designated OH-EM-3, was photographed during wind-tunnel tests (see "Moscow Flap," above).







Efficiency at 250°C

Increasing speeds in flight, with the attendant high temperatures encountered, demand of the component designer a motor that will maintain efficient operation through an exacting temperature range. From Plessey comes the S1510 AC motor. This high power-to-weight ratio three phase motor and brake is specially designed to operate efficiently at ambient temperatures up to 250°C.

Many of the very wide range of Plessey AC and DC motors are fully type approved to official specification.

Manufacturers and Design Engineers are invited to ask Plessey for comprehensive details.

by these Plessey motors

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For qualified engineers who would like to work on advanced equipment of the type illustrated, the opportunities are outstanding. Write to the Personnel Officer for information.

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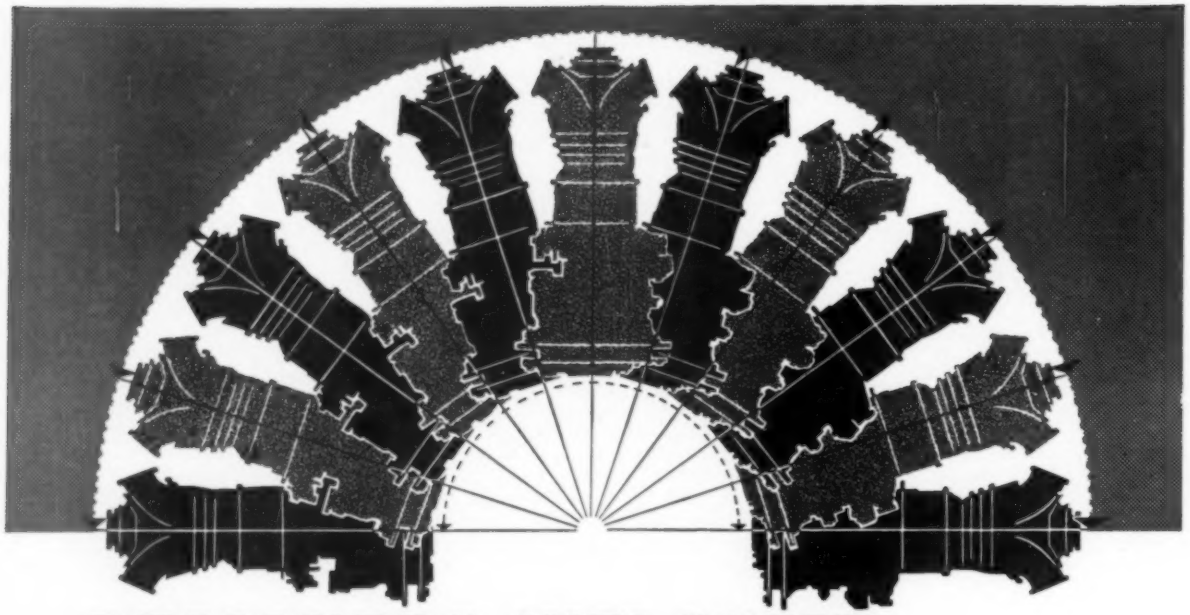


DESIGNERS WELCOME THE NAPIER GAZELLE

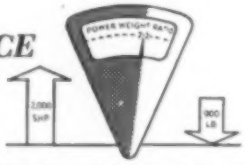
'Any angle' installation gives greater freedom

Napier's Gazelle offers a welcome break to 'tied' helicopter designers. This rugged free-turbine engine can be mounted on simple supports in the helicopter structure UPRIGHT, HORIZONTALLY, OR IN ANY POSITION IN BETWEEN.

This 'any angle' installation relieves the designer of many accepted limitations. It also gives him more opportunity to make proper use of fuselage space—valuable space which should, after all, be used for payload accommodation.

The Bristol 192—chosen by the Royal Air Force—is powered by two Gazelles.

HIGH PERFORMANCE —LOW WEIGHT



The Gazelle has an impressive power/weight ratio. Originally designed for a power output of 1,260 s.h.p., it is now well on the way to developing 2,000 s.h.p. for a weight of 900 lbs.—a ratio of 0.45 lb./s.h.p. By removing the need for clutches, cooling fans, etc., the free turbine arrangement knocks pounds off the weight of the transmission mechanism.

30% RESERVE POWER

The design of the Gazelle provides a range of ideal helicopter powers. Among them are short-period emergency power outputs up to 30% above the normal maximum. Helicopters demand tough, reliable engines: the Gazelle is designed for strenuous duty and long service between overhauls. And when the time for overhaul comes, economical speedy maintenance is assured by the Gazelle's essential simplicity and the 'unit' principle on which it is built.

REPAIRS BY REPLACEMENT

This principle means that Gazelle components and assemblies are interchangeable—and easily accessible. Reduction gear, free turbine, compressor turbine and combustion system, compressor and accessories can all be replaced as self-contained, individually tested assemblies. The metering control unit can also be replaced as a rig-tested unit needing only minor adjustment.

D. NAPIER & SON LIMITED, LONDON, W.3

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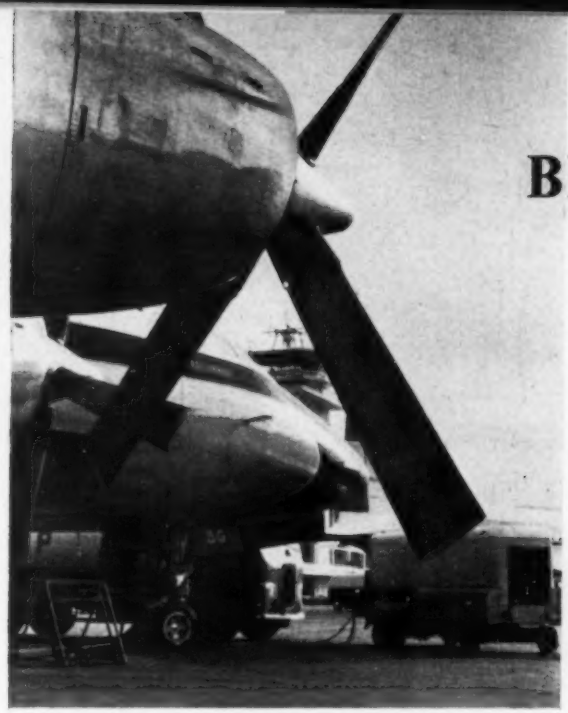
CBC 67

BRITANNIVERSARY

A Year of Service with B.O.A.C.

BY CAPTAIN LINCOLN LEE



WHEN the Britannia 102 went into service on February 1, 1957, the writer outlined his views on the characteristics of the aircraft. He now sums up the first year of operation, with acknowledgments to B.O.A.C. He emphasizes that the views expressed are his own and not those of the Corporation, in which he is a Britannia captain.

THE purpose of this article is not to give the official statistical account of the first year of B.O.A.C.'s operations with the medium-range Britannia; such records are instructive to study, but dreary to read. Rather is the intention to describe possibly significant events as seen by just one of the many pilots who have been operating these aircraft on the routes; describing impressions rather than facts, the impressions being personal and not official.

From the pilot's point of view the Britannia is an interesting and exhilarating aircraft to fly. When it is going, there is nothing better. Its virtues are many; its vices, in terms of alarms and frightening moments, nearly non-existent. Looking back over the first twelve months of service, a great many satisfying moments spring to mind. . . . Taking off from Tokyo and comfortably overtaking three competing aircraft between there and Hong Kong, beating one of them by an hour and a half; weaving on the search radar for hours on end across the Indian Ocean; avoiding weather which had caused at least one aircraft to turn back; making one's first landing at Hong Kong, and knowing that of all aircraft the Britannia can be relied upon to stop on a short runway; demonstrating a V_2 climb on take-off at Johannesburg at operating weight, and reaching 500ft by the end of the runway, despite the altitude.

Of frightening moments the writer has had none. At the risk of shooting a line, it may be confessed that the worst moment was when taxying out at a certain African airport; on looking sideways to check the propeller clearances it was observed that the blades were cutting the long grass in great swathes like some new-fangled and fearfully expensive scythe. A disconcerting spectacle, although no damage resulted. The only engine failure experienced was so quiet as to be almost eerie. The fault, originating at the fuel-pump drive, caused no splutterings, bangs or lurches, and passed unobserved until it was noticed that torque and c.r.p.m. had fallen. Probably the most alarming experience for anybody in the fleet was the wing fire which occurred on one aircraft shortly after leaving Beirut. Several gallons of fuel spontaneously ignited in an unprotected zone above No. 2 engine; although the fire burnt for only a short time, the experience was not one to be welcomed. Steps have, of course, been taken to prevent any recurrence.

During the earlier months of operation the biggest single problem was that of the Proteus icing. As had been predicted, the glowplugs were found to prevent the majority of flame-outs. Within a month of services starting, however, an aircraft on an Australian proving flight experienced a new phenomenon. On several occasions, during automatic relighting, engines were shut down by the overspeed limiter and had to be relit manually. This discovery was disconcerting; not only did it introduce a new type of flame-out which might be worse than the original, but also, flying as we were at the time over Indonesia, we wondered at first if perhaps it was being caused by clear-air icing—some of the ice-falls took place three hours after leaving cloud. But this worry about clear-air icing was soon dispelled; there has been no evidence that any Proteus has accumulated ice except in cloud or precipitation, and an ingenious delay incorporated in the overspeed limiter system, whilst retaining the protection of the system, effectively eliminated any recurrence of this trouble.

As more services were introduced, especially through monsoonal areas, engines began to suffer an accumulation of ice damage, and failures began to occur in flight. One feature of these failures was remarkable and reassuring; although it might be expected that when a compressor-turbine system spinning at 11,350 r.p.m. started to shed blades extensive damage could result, in all cases the engines seem to have contained themselves completely. In fact, in many cases damaged engines continue to run efficiently until normal shut-down after landing, at which stage the compressor or turbine seizes. Another feature caused a certain amount of worry. On some occasions, if failure occurred in flight, it could be mistaken for a simple ice flame-out. Attempts made to relight under such conditions would aggravate the failure, so that it was necessary to be doubly alert during "bump" conditions.

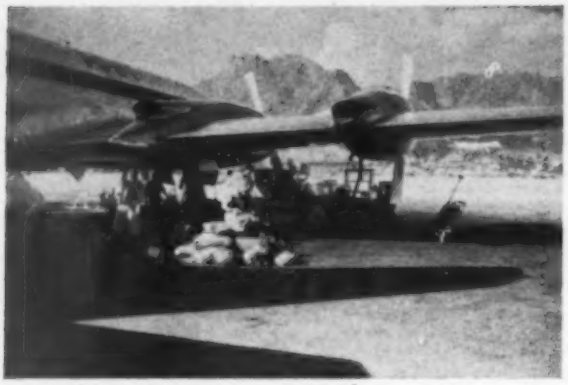
The increase in engine failures resulted in a change in operating policy within a few months. Instead of doing "high-speed low-level" cruises, which meant a normal altitude of 18,000 to 24,000ft, it was decided to avoid the most critical icing band between +4 deg C and −11 deg C whenever there was extensive cloud. The sectors mainly affected were those over India, but once this policy had been decided upon every effort was made to avoid the icing band. At first sight it seemed that the restriction might be a severe blow to the economic operation of the aircraft, but here the versatility of the turboprop almost compensated for its inadequacies. It proved to be almost as fast—within five minutes—to fly from Karachi to Calcutta, for example, at about 13,000ft, cruising near VNO, as at higher altitudes. Furthermore, the extra fuel required to be uplifted was only about five per cent.

It was still possible to get caught in the icing range on some occasions, or, of course, to suffer engine-bumping whilst flying in air much colder than −11 deg C. On one occasion the writer misjudged the sharp temperature-fall in a front near Khartoum and, by the time A.T.C. clearance had been granted and a descent made, some forty bumps and auto-relights had been recorded. On this occasion no damage to entry guide vanes or compressors could be detected after landing. But many pilots share the view that the torque surges suffered by an engine under such conditions must do harm in the long run, and every effort is made to keep out of icing cloud when practicable.

Another thing which gave trouble during the first few weeks of service was the quite frequent receipt of fire warnings from the freight holds. Many of these were genuine and, though not due to real fires, were caused by overheating of various electrical components, such as recirculation fans and feel-simulator motors. But other alarms were false and were caused by arctic fog from the air-conditioning system. When seen for the first time, it was difficult to believe that this fog was not caused by fire—it was generally described as being "more like smoke than smoke." The conditioning system gave some other trouble in early operation; often the distribution of heat throughout the aircraft was erratic, whilst a number of components failed. Of recent months, however, it has worked well, proving simple to control; whilst overheating of electrical units has become rare.

A type of engine fault which caused some confusion when first experienced was a damaged first-stage turbine. When this occurred, and because of the inefficient absorption of power by that turbine, which drives the compressor, more energy was available for the propeller turbine; thus the indicated torque would increase. Needless to say, this did not indicate a more powerful engine for very long; the high j.p.t. and fuel flow warned of impending failure within the next few dozen hours.

As might be expected with any new aircraft, there has been a tendency for new snags to show themselves in rapid succession on various aircraft in the fleet. During the summer, for example, our dearly loved search radar had a bad period of unserviceability due to various component failures, caused mainly by tropical overheating. At another stage, fuel booster pumps failed with great regularity, or there might be some sort of actuator giving trouble. In December a crisis was caused by fuel leaks, aircraft after aircraft



BRITANNIVERSARY . . .

becoming grounded awaiting spares. There had been a period in the autumn when it seemed that the Britannia was settling down to steady on-schedule operations, but a whole series of delays in November and December played havoc with schedules, slipping and economics.

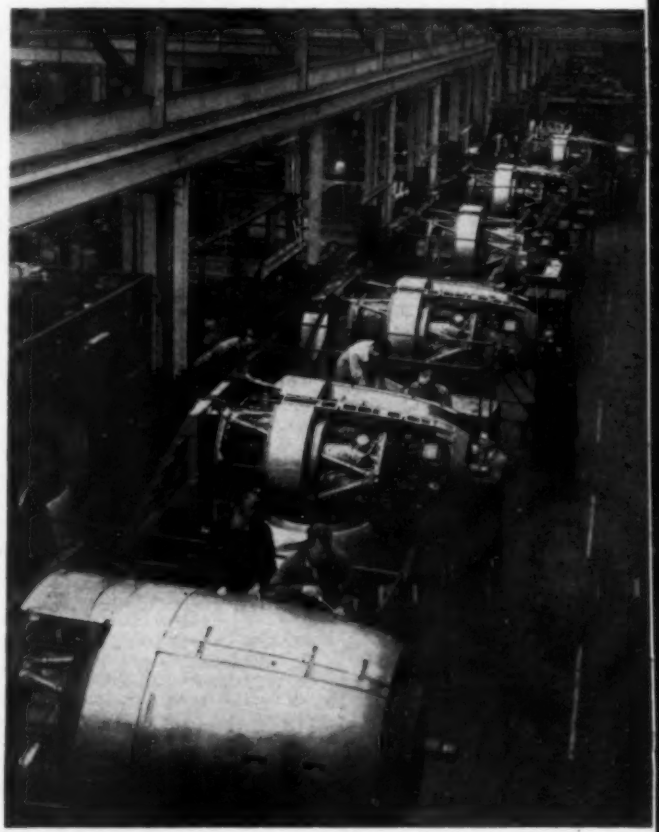
Blame for many of these delays could be placed fairly on various component failures, but a great many were chronic bad luck. At an Indian airfield a Britannia subsided through the tarmac whilst taxying. On previous occasions they had stuck, unharmed, in soft tarmac. But this time the port undercarriage went right through, so that extensive damage was suffered not only by the gear and doors, but also by engines, three propellers and fuselage. One aircraft was delayed awaiting a single replacement hydraulic valve. The aircraft bringing out the spare, itself got caught by fog at Zürich, so that the ensuing delay was far more than it should have been. Another aircraft—a York freighter carrying a.o.g. spares for a Britannia—was held up for days in India, the entire crew down with Asian 'flu. Yet again, the long fog in December played havoc with aircraft struggling for a high utilization rate. These are the sort of eventualities against which enthusiasm, planning and hard work offer little protection.

Another item which contributed to delays was the *Order on Flight-times Limitations*. Despite its value and good points, this is so restrictive in some directions, and so confusing to interpret, that on long routes such as those to Tokyo and Sydney it can thoroughly aggravate every delay. Yet another difficulty in planning has been the impossibility of estimating the time taken for component changes where the local engineering staff have not had previous experience of the job. Everybody can estimate the time for a Merlin magneto change; but on the first occasion when something like a cold-air-unit turbine has to be changed at an overseas station the time may be almost anything over two hours. Despite delays, however, we have not suffered the grounding that both Argonauts and Stratocruisers suffered at some stage in their earlier life.

The Corporation has been remarkably efficient during these various vicissitudes in the way it has kept its crews abreast of technical developments. Obviously this was desirable, bearing in mind changes in operating techniques, varying modification states and continued gains in experience; nevertheless, putting it into effect must have been very hard work for the technical staff and fleet management.

Other things have characterized the first year's operations. On Eastern routes, crews have not kept together as such. An aircraft flying from, say, Bombay to London might change pilots at both Karachi and Beirut, change engineer at Beirut only, and yet keep one navigator the whole way. Despite some advantages, this system has been most unpopular, and will have been eliminated to some extent by the end of January. During the year the radio officers were used less and less, the work being taken over by the pilots. This change seemed inevitable with such reliable equipment on board, but most pilots regretted the loss of such a stalwart crew-member. Yet another feature of fleet policy was to try to have all pilots qualified on all routes. This was something most pilots would welcome. It was pleasant to alternate between the shorter services to Johannesburg and Aden, and the long ones to Sydney and Tokyo; and crew utilization was more satisfactory.

What other outstanding memories are there of the year's operating? Speaking personally, the most invigorating sector was on a proving flight from Darwin to Djakarta. Captain F. A. Taylor, in command, was operating under circumstances which would not normally be considered with passengers on board. Autopilot, feel-simulator, and search radar were all unserviceable, and we ploughed across the Timor Sea through a cyclone which inflicted both hail and lightning damage. Even in these conditions, the aircraft handled well; it felt safe and inspired confidence. Then there was the experience of a three-engine ferry from Bahrein to Beirut. There is nothing very remarkable about a three-engine ferry: but on this occasion there was extensive bad weather over Iraq, and aircraft of other companies, flying at 17,000 and 19,000ft, were reporting turbulence, icing and lightning. The Britannia went



Preoccupation in the Bristol factories now, of course, is with long-range Britannia production. Here are seen the Proteus 755 production line and (extreme right) the 310-series production scene at Filton.

The three pictures on the left show a B.O.A.C. Britannia banking to clear the ridge after taking off from runway 13 at Hong Kong; Christmas mail being loaded at Kai Tak Airport, Hong Kong (Lion Rock can be seen above the nose of the aircraft); and a Britannia passing over the picturesque Junk Harbour at Cheing Chow just before arriving at Hong Kong. (Right) Crews operating Britannia services on the South Africa route met with a variety of reception committees—such as these camel troops at Khartoum.

cheerfully up to 22,500ft despite its lack of one engine, and over the top of all weather.

There was the gradual realization, as operating experience was accumulated, that on the routes we cover there is virtually no worry about fuel. A Howgozit is still kept on all sectors; but should the fuel situation deteriorate, it can in almost all cases be restored by ascending two or four thousand feet. Perhaps most satisfying of all, especially to members of a fleet working in a constant glare of publicity, has been the sight of large payload figures on the load-sheet and full passenger cabins on a great many sectors. On twenty successive legs on the Australian route, the writer recently averaged almost exactly 15,000 pounds' payload. If we can do this even during our first year of teething troubles we should be able to make some big money as time goes by.

Much of the passenger reaction to the Britannia has been what anyone used to passenger-handling would expect. Operate on time, and the passengers are wildly enthusiastic, especially in the first-class cabin. The aircraft, they say, is quiet, luxurious, smooth, comfortable—a pleasure and a privilege to ride in. Get a couple of hours behind schedule and the story changes; the noise gets on their nerves, the tail sways; the passengers, especially in the tourist cabin, become critical of the small toilets, plastic fittings, narrow aisle.

One thing has become far more common than before, and that is sheer boredom amongst the passengers. In September, when I was chatting to travellers on the last six-hour sector of their 12,000-mile flight to Sydney, several of them complained to me of being so bored by the same steady uneventful passage of time and space that they would almost welcome some excitement. That, of course, is how airline flying should be, the objective for which the industry has been striving these past forty years. Obviously something will have to be done to entertain the customers. But meanwhile the best compliment that I can pay to the Britannia from the passengers' point of view is that rough riding, failures and alarming adventures have been eliminated to a degree which leaves most of them bored.

Editor's Footnote: *It is appropriate to add here the news that the newest Britannia operators, Aeronaves de Mexico, appear to have settled down remarkably quickly with their two Britannia 302s. Since the airline began daily return flights between Mexico City and New York on December 18 there have been no technical delays caused by the aircraft or its engines. Until January 6, all flying had been with one Britannia, XA-MED, which was utilized at a rate of nearly 12 hours per day. Inevitably, the Mexico - New York record fell to the Britannia, which did its fastest trip in 5hr 8min—nearly one hour better than the previous best time over this route.*

British European Airways and VTOL

What the Corporation would want: Points from a Requirements Study

THOUGH B.E.A. has no immediate requirement for a VTOL aeroplane (notwithstanding its interest in the Fairey Rotodyne) it has thought a good deal about its requirements in this direction. Below are selected points from a study by Mr. R. H. Whitby, of the Corporation's project and development branch, in which some provisional requirements—including a cruising speed of not less than 350 m.p.h.—are set out. **See also page 160.**

IN the development of air transport the VTOL aircraft can give improved direct communications between many points now served by conventional aircraft by eliminating much of the surface travel to and from the airport; it can open up new routes without the need to build new airports or improve existing ones; it can provide a convenient means of feeding major airports with their good frequency of aeroplane services, and in certain conurbations can supply a link between airports. Needless to say, the practicability of such new and improved services depends on the safety, reliability and cost of the VTOL aircraft available to operate them. It is essential that the level of external noise, blast and atmospheric contamination be acceptable for VTOL operations into and out of built-up areas.

The basic factor affecting operational unit cost (cost per seat mile) is the transport capacity of the aircraft, i.e., seat-miles per hour, the product of capacity payload and block speed. Past and recent experience in civil air transport operations shows that during the life of an aircraft type and development of traffic and the operation of other factors are constantly pressing on unit aircraft capacity. This pressure is reflected in the steady increase, seen all over the world, in payload capacity of transport aircraft, for specific routes and route systems. Hence, the largest payload capacity, and size of VTOL aircraft, which is generally agreed to be within the competence of existing design knowledge is specified.

This line of approach leads to the broad definition of an initial design payload and "developed" payload. Thus, the design initial capacity should not be less than 40 seats over a 200 n.m. stage with a standard seating arrangement. The ultimate development should be capable of accommodating at least 50 seats over a 200 n.m. stage.

The performance required under normal and one engine operative conditions is given below. Unless otherwise stated, maximum take-off weight and ISA+10 deg C and 80 per cent relative humidity conditions are to be assumed. All performance is outside the ground cushion:—

The payload should be made up of passengers and associated baggage at 200 lb per passenger, together with a passenger service allowance of 10 lb per passenger.

The fuel load for any stage is to be calculated on the engine manufacturer's stated fuel consumption+3 per cent at the power output required on climb, descent and at cruise altitude at the average cruising speed defined below together with the following reserves: (a) Fuel needed for an overshoot and climb to 1,000ft and second landing; (b) the fuel required at the minimum power for level flight for 60 min duration (n.b. this reserve is for hold-off and diversion).

Tankage shall be provided for stages of up to 300 statute miles length in a 40 kt head wind with reserves and allowances (a) and (b) above.

The cruising speed should be not less than 300 kt with the engines operating at the manufacturer's recommended cruise power, and the aircraft at 95 per cent of the maximum take-off weight.

Vertical rate of climb at sea level and maximum continuous (or one hour) rating of all engines shall not be less than 600ft/min, without ground effect, and at zero forward airspeed. Hovering ceiling without ground effect and with maximum continuous or one hour rating of all engines shall be at least 5,000ft. With the critical engine or engines inoperative and the remaining engine(s) operating at the maximum continuous or one hour rating, the rate of climb at the best forward speed for climb shall be not less than 150ft/min at all altitudes between sea level and 5,000ft, and the gradient of climb not less than 2.5 per cent.

The VTOL aircraft should be capable of operation out of and into sites of limited dimensions closely surrounded by obstructions. The characteristics of such a site may be taken as those described in the report of the second IATA Helicopter Meeting (Brussels, 1955). In the event of failure of the critical engine or engines at any stage of the take-off it shall be possible to return safely to the take-off area or continue flight and land elsewhere. It shall be possible without requiring exceptional pilot skill to approach and land in a crosswind at least equal to the minimum level flight speed of the aircraft with the critical engine or engines inoperative and the remaining engines(s) delivering maximum or emergency power.

Experience in helicopter operations to the present time has emphasized the need for greatly improved handling characteristics in instrument flight, which will be a regular feature of scheduled operations. The essential need when using restricted sites for steep flight paths at low forward speed in landing and take-off is for good flying qualities under these conditions, both under full power and in the event of engine failure. Further, operation into small sites closely surrounded by obstructions will, in gusty conditions, demand good co-ordination of control and crisp response.

C.A.R. (Sections 6.120 to 6.123) and B.C.A.R. (Section G, paras. 2-6 to 2-10) lay down minimum requirements to be met by rotor-craft, and should where appropriate be fulfilled by VTOL aircraft.

An integrated autopilot flight system shall be installed. In addition, it shall be demonstrated that the information offered by the instrument panel is sufficient for a normally skilful pilot to maintain control of the aircraft while forward speed is increased from zero to the minimum for steady forward flight without autostabilization and while power is increased to the maximum continuous or one hour rating.

A weight provision of 500 lb for communications and navigation equipment shall be allowed, together with appropriate space provision.

The undercarriage shall be so designed that the aircraft can be manœuvred into any desired position with no point of the aircraft passing outside an area 400ft × 200ft. It shall be possible to move the aircraft with a single tractor which is rigidly connected to the aircraft and the manœuvring required shall not be excessively protracted.

A means of rapidly stopping the rotors which does not require heavy maintenance shall be provided. Means shall be provided to prevent "blade-sailing" while starting or stopping the rotor in steady or gusty winds up to 50 kt. When required by the operator, it shall be possible to provide means for rapidly folding any fixed surfaces to facilitate parking in confined spaces.

The time from tanker in position to tanker away, employing the normal means of refuelling, shall not exceed five minutes when the tanks are completely filled, while in off-loading fuel the time taken to remove 10 per cent of the fuel capacity shall not exceed three minutes. Pressure refuelling is required together with alternative means of "gravity" refuelling not requiring special equipment. The pressure refuelling point shall be directly accessible from the ground. Improved accuracy fuel gauges are required.

Doors (other than servicing doors) should be on the port side of the aircraft. Simultaneous loading or unloading of passengers and baggage/freight shall be possible (i.e., baggage/freight shall not have to be loaded through the passenger door). Doors shall be so positioned that this will still be possible when a mixed load of passengers and freight is carried. The principal passenger door shall not be less than 2ft 6in × 5ft 6in high. Airstairs are required.

The baggage/freight and secondary passenger door shall be at the opposite end of the cabin to the principal passenger door and so designed that a truck can approach the opening without obstruction. This door should be large enough to admit a spare engine of the type installed in the aircraft and, in any case, not less than 4ft 0in × 5ft 6in high. Emergency exits, other than doors, shall open inwards.

Pressurization is required so that cabin altitude does not exceed 8,000ft and rates of change of cabin altitude do not exceed 300ft/min. At least 2 lb/min of fresh air per seat is required for passengers and crew at all heights.

At a distance of 200ft the overall noise level during landing or take-off should not exceed 90 db above 2 dynes/sq cm.

The cabin width at 25in from floor level should permit the installation of seats of the following dimensions: (1) width between arm-rests, 16½in; (2) width of arm rest, 2in; with a minimum gangway of 15in. Seat pitch should be 34in minimum, and a headroom in the gangway should be 6ft minimum. A luxurious seat is not needed, the standard of comfort required being that for a two-hour journey. Seats shall be mounted on rails.

Total volume provided for stowage of baggage, registered and unregistered, shall assume a density of 9 lb/cu ft of usable gross volume. In addition to space in the registered baggage compartment stowage shall be provided for unregistered medium sized suitcases carried by the passengers themselves in racks near the passenger entrance door. The registered baggage compartment shall be so laid out that the flight attendant can sort registered baggage in the air.

(*Continued on page 160.*)

VICTORS

SHIELD AGAINST AGGRESSION

Alfred the Great, after a long campaign, conquered the Norsemen who were ravaging his kingdom and brought peace to England. His reign — nearly 1,100 years ago — saw the birth of Britain's navy, her sure shield for centuries.

Today defence of these islands is entrusted to air power — and in the air there is none more potent than the . . .

VICTOR—BRITAIN'S PREMIER STRATEGIC BOMBER

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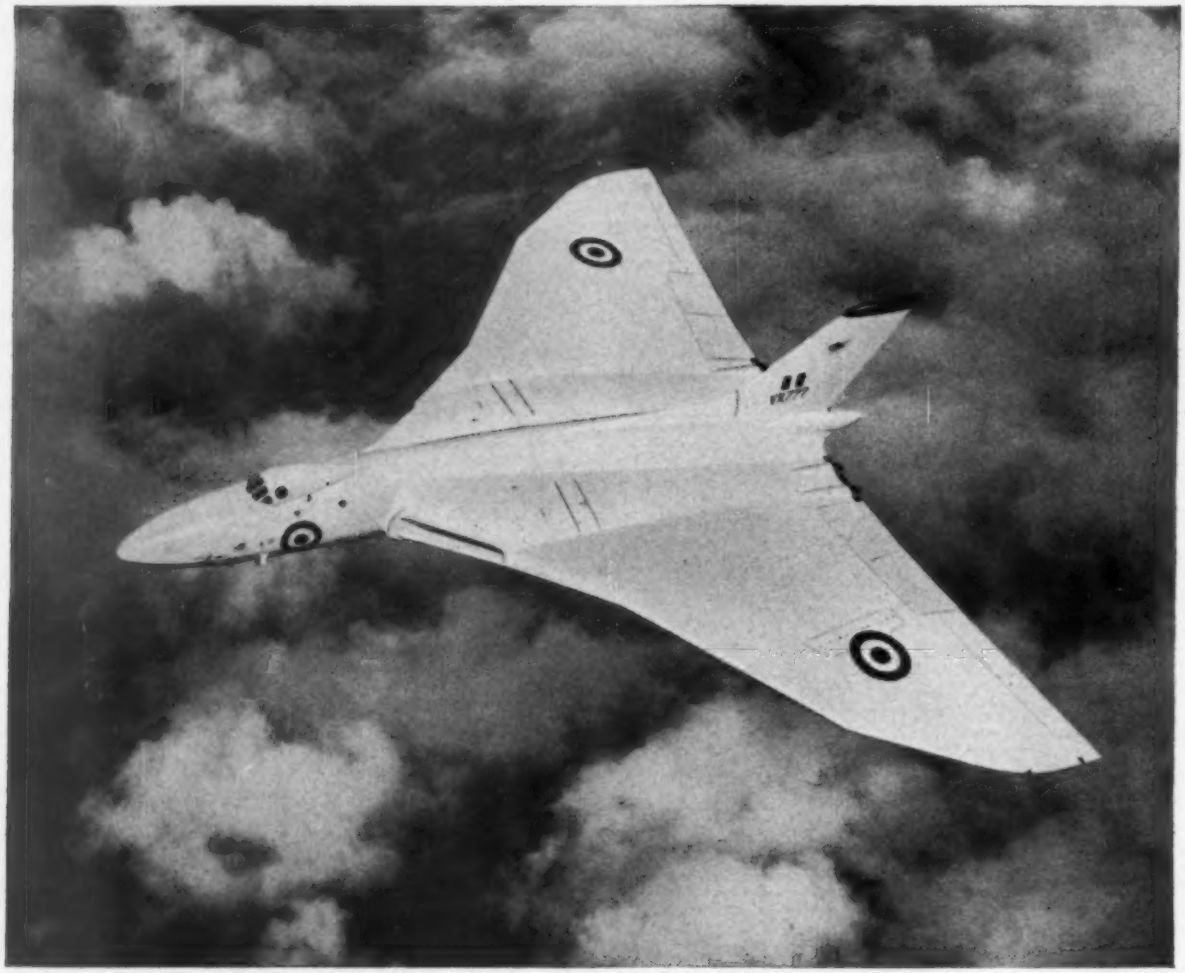

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Club and Gliding News

LASHAM PROJECT

Design for a Future Gliding Centre

"Flight" photograph

DISPLAYED for the first time at a recent Kronfeld Club debate, drawings and a model of a projected gliding centre aroused much interest among gliding enthusiasts from many clubs. The centre has been designed by a member of the Surrey Gliding Club, Lasham, at the suggestion of the club's long-term planning committee.

As reported on previous occasions in *Flight*, negotiations are proceeding on the subject of long-term security of tenure for the gliding clubs at Lasham. Clearly the idea of a large centre is nothing more than a project at present, but the proposed scheme does show the type of thing which might come to pass at some future date—given a secure site and some £100,000. The gliding centre is described by its designer as follows:—

The building illustrated was designed to a schedule of accommodation which was devised for a possible future gliding centre. The site for the centre remains uncertain. Because of the expense involved in the complete programme, construction in three distinct stages was envisaged. The central main club-house would be built during the first phase, followed in turn by the flanking blocks for dormitory and administrative accommodation.

From the point of view of outlook it was considered an advantage to locate the restaurant, lounge and bar on the first floor of the club-house. The ground floor contains secondary accommodation: in the first instance this area would be utilized for offices and general administrative work, and possibly a limited amount of sleeping accommodation. The partitions between restaurant, lounge and bar can be opened to give an unrestricted floor area for special social occasions.

The dormitory block provides sleeping accommodation for 160 persons in sub-divided dormitories (five on each floor, each sleeping 16 people in two-tier bunks); and for an additional 12 persons in six double bedrooms. Baths, showers, changing rooms and drying cabinets are provided on each floor, in addition to heated blanket stores. Certain portions of the ground floor areas would be allocated for women's accommodation.

A low-pressure central-heating system, employing oil-fired boilers, is envisaged. The capacity of the system would be sufficient to cope with the heating demands of future workshops which would eventually be constructed.

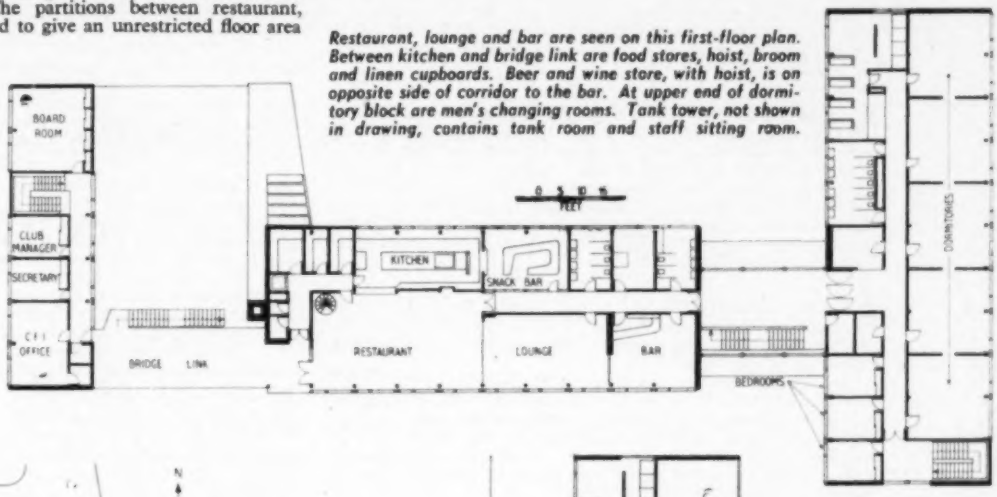
Between the club-house and the administration block is an open patio which could be used for open-air film shows and other entertainments. The bridge link providing communication between the two blocks can be used as an open-air extension of the restaurant in summer, or to provide extra seating space for the patio entertainments.

Structural design of the buildings includes a reinforced-concrete frame with pre-stressed floor and roof slabs. External walling would be formed mainly with pre-fabricated timber window units. Areas needing fire protection would have concrete upstand walls; while vertical boarding on timber framing would be used where a reduction of glass window-area was considered necessary.

Total floor area for the complete scheme is approximately 20,000 sq ft, and the estimated cost would be in the region of £100,000.

F. K.

Restaurant, lounge and bar are seen on this first-floor plan. Between kitchen and bridge link are food stores, hoist, broom and linen cupboards. Beer and wine store, with hoist, is on opposite side of corridor to the bar. At upper end of dormitory block are men's changing rooms. Tank tower, not shown in drawing, contains tank room and staff sitting room.



Ground floor plan (below) of the projected centre. Three stores on corridor between lecture room and boiler room are for parachutes, weak links and barographs. Four telephone kiosks are in entrance hall. Women's changing rooms are at upper end of dormitory block.

Many well-known racing personalities attended the R.Ae.C. dinner reported below. They included (left to right) Jim Denyer and Fred Dunkerley, King's Cup winners for 1956 and 1957; Percy Blamire and Brian Iles. Right, the starter's ashtray model presented to Philip Mayne.

Club and Gliding News

AIR-RACING DINNER AT ROYAL AERO CLUB

THE introduction of a three-day race meeting at Coventry this year was announced by Col. R. L. Preston at a Royal Aero Club dinner on Tuesday, January 21. Guests of honour at the dinner were F/L. H. B. Iles, British Air Racing Champion for the second successive year, and Mr. Fred Dunkerley, winner of the 1957 King's Cup Air Race.

This year's Coventry meeting, Col. Preston said, would comprise three days' racing, July 10, 11 and 12, with the three rounds of the three class races on the first two days and the King's Cup race (together with the Lockheed aerobatic contest and the customary air display) on the Saturday.

A spirit-lamp cigarette lighter was presented to F/L. Iles by Mr. Stewart Scott-Hall, chairman of the club's records and racing committee. In his speech of thanks F/L. Iles revealed that he had realized two ambitions; in addition to winning the championship, he had appeared on the front page of the *News of the World*.

The speaker's thanks to the race officials were warmly repeated by Fred Dunkerley, who recollected that it had taken him nine years to beat his fellow fiddlers and realize his own ambition to win the King's Cup.

An important field for development by the British aircraft industry, Mr. Dunkerley urged, was the production of a modern light twin-engined aircraft. There had been nothing since the Gemini. He was proud to be the first member of the Lancashire Aero Club to win the cup, and he hoped it would be possible to bring new blood into British air racing.

The surprise presentation of an ash-tray trophy to Philip Mayne, chief starter of the Club, by Nat Somers on behalf of the Throttle-benders concluded the evening's formal activities. On the ash-tray was mounted a model of Mr. Mayne in action, flag raised and head bent down towards his stop-watch. The model had been based on *Flight* photographs of Mr. Mayne taken at various air races.

FOURTH International Air Rally to be organized by Channel Islands Aero Club (Jersey) will take place on the week-end of May 9-11. A banquet and ball will be held on the evening of Friday, May 9, which is Liberation Day and a public holiday in the Islands.

ANNUAL totals of flying hours logged by Plymouth Aero Club at Roborough have shown a steady increase over the last four years. From 1,703 hr in 1954 the figure has risen, through 1,970 hr in 1955 and 2,434 hr in 1956, to 3,282 hr during 1957. Last year's operations included the achievement of 32 first solos, 20 P.P.L.s and four C.P.L.s. The club's first Chipmunk, G-AORV, has been purchased and should join the fleet soon. On February 14 the club is celebrating its 30th anniversary with a dinner dance at the Moorland Links Hotel, Yelverton.

RECONSTRUCTION of Arrow Active II G-ABVE by Rollason Aircraft and Engines, Ltd., at Croydon is now well under way, together with the construction of the company's Bishop conversion of the Tiger Moth.

The Bishop will be essentially a single-seat Tiger, with a pressure-fed fuel tank in the front cockpit. The upper-wing tank will be removed and faired over; smaller wheels will be fitted; lightweight fabric and thin plywood leading edges will be employed; and the elevators are to be extended by 4in each side. It will be powered by a Gipsy Major 1c engine, and will be capable of sustained inverted flying.

CHIPMUNK G-AORN is soon to join the fleet of Exeter Aero Club. Last year's hours flown amounted to 1,666, an increase of 344 over the 1956 figure, during which time 14 P.P.L.s were gained and 17 first solos were achieved. A number of potential commercial pilots were among the club's temporary members during 1957. The club's new briefing room and library is reported to be a great success, particularly during bad weather.

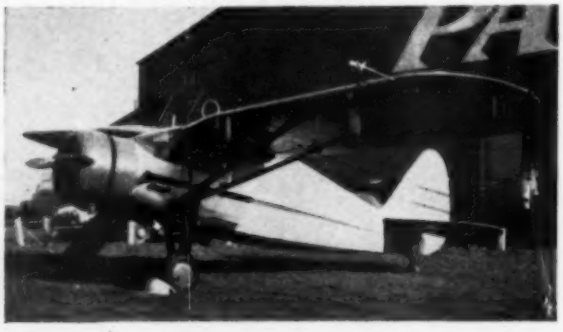
ANNUAL Ball of the British Gliding Association will take place this year from 8.30 p.m. to 2 a.m. on Friday, March 14, at Londonderry House. Tickets, price £1, are available from the B.G.A. or from member-clubs. The following afternoon, March 15, the association's annual general meeting will be held, preceded in the morning by two specialist conferences for instructors and for club secretaries, managers and treasurers.

STATISTICS of the flying carried out during 1957 at Lasham Gliding Centre show a record total of 22,297 launches, excluding activity during the National Gliding Championships. There were 2,533 winch-launches, 16,852 by auto-tow, and 954 by aero-two (club flying), accounting for 2,423 hours and 3,841 cross-country miles. Private owners logged 929 hours and 6,466 cross-country miles. Certificates gained comprised 48 As, 49 Bs, 29 Cs, 26 Silver C legs, 11 Gold C legs and 7 diamonds. During the national championships 818 competition launches by aero-tow resulted in 1,461 hours and 27,132 cross-country miles.

A JOINT one-month programme of research into wave lift near mountains is now being carried out at St. Auban by the French meteorological office, the scientific branch of the ministry of defence, and the Service de la Formation Aeronautique et des Sports Aeriens. This project follows similar programmes in 1956 and 1957, and both sailplanes and powered aircraft are being employed for a variety of measurements. Cotal radar is being used to track balanced balloons maintaining specified heights, and a complete radio-sonde station is also in operation. The observations from St. Auban will be complemented by those from jet aircraft from the test centres at Marignane and Istres, which will fly in the area within 50 km radius of St. Auban, at heights up to 65,000ft.

POLISH crews and reserves for the World Gliding Championships, according to a report from Warsaw, entered a training camp on January 16 to commence intensive preparation for the contest. All costs of training are borne by the State.

TWO landing strips for light aircraft are among new facilities at Goodwood racetrack which should be completed by next Easter. The strips are 2,100 and 2,400ft in length.



Argus N9996F, owned by Capt. Young of P.A.W.A., is equipped with D/F and Narco Simplexer. Previously British-registered as G-AIZE, the machine was photographed at London Airport recently.

Fairey flies the first Vertical Take-off Airliner

Adding achievement to achievement, Fairey Aviation have now built potentially the most important transport aeroplane in the world, the Fairey Rotodyne.

Carrying 48 passengers or 4½ tons of freight it takes off vertically as a helicopter and having gained height flies forward as a normal twin-engined airliner.

It is the most adaptable rotary-wing aircraft in the world and the first to offer operating economy directly comparable to that of fixed-wing aircraft over ranges of up to 400 miles.

The arrangement within the Rotodyne's capacious fuselage can readily be adapted to suit civil or military applications.

Powered by two Napier Eland propellor-turbines with Fairey Pressure-Jets at the rotor-tips for take-off and landing.

FAIREY *Rotodyne*

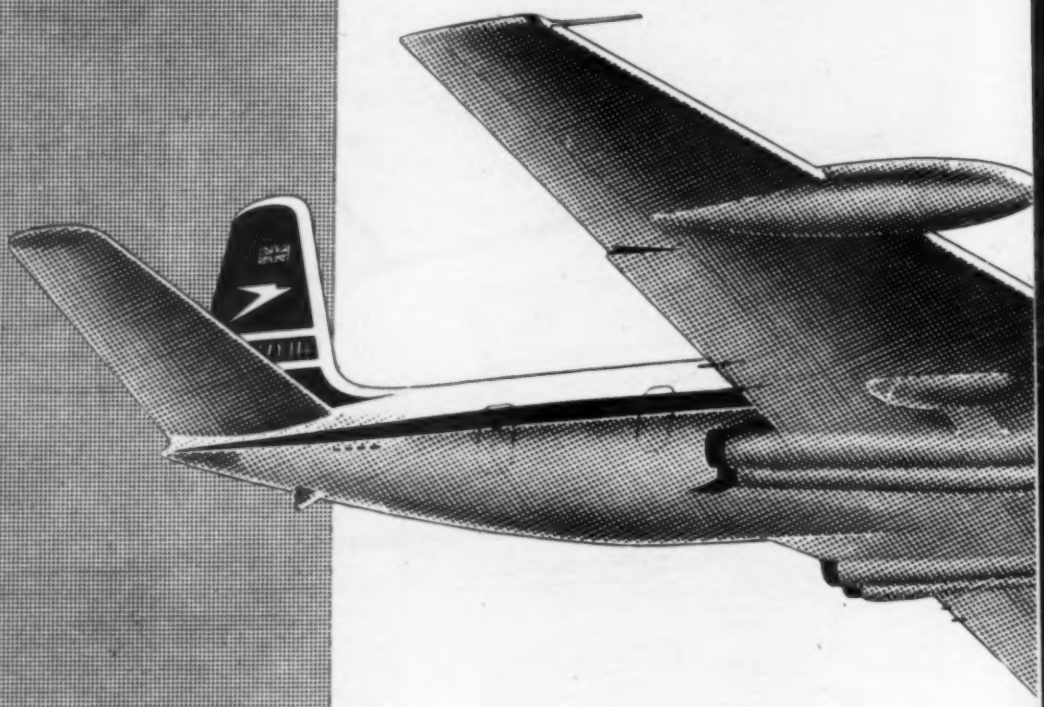
48 passengers · 185 m.p.h. cruising speed

400 miles maximum range.

THE FAIREY AVIATION COMPANY LIMITED · HAYES · MIDDLESEX

ENGLAND · AUSTRALIA · CANADA

Breakfast in Western Europe



The passenger will decide

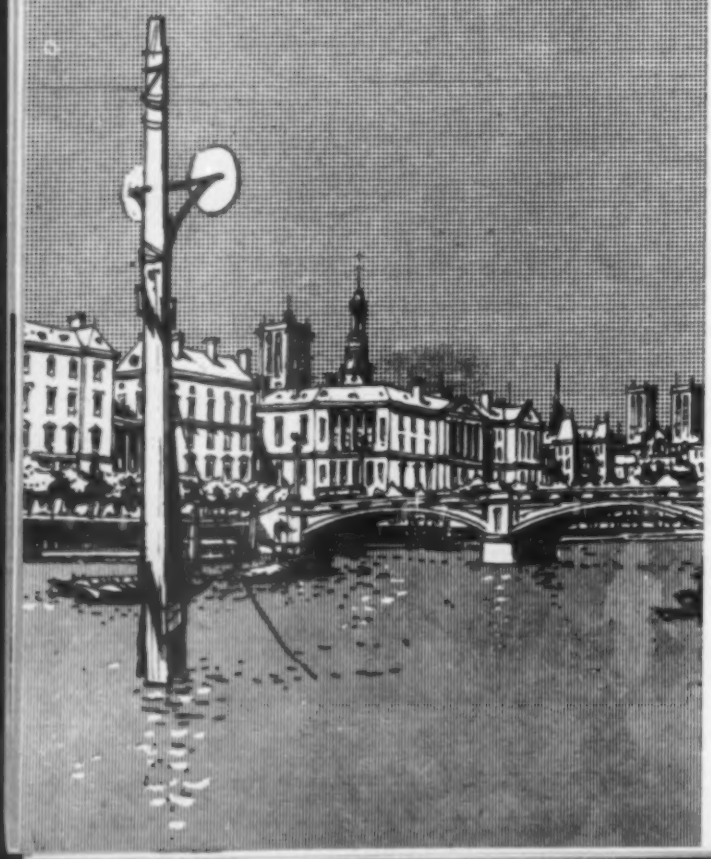
The passenger will choose the jet

The new COMET

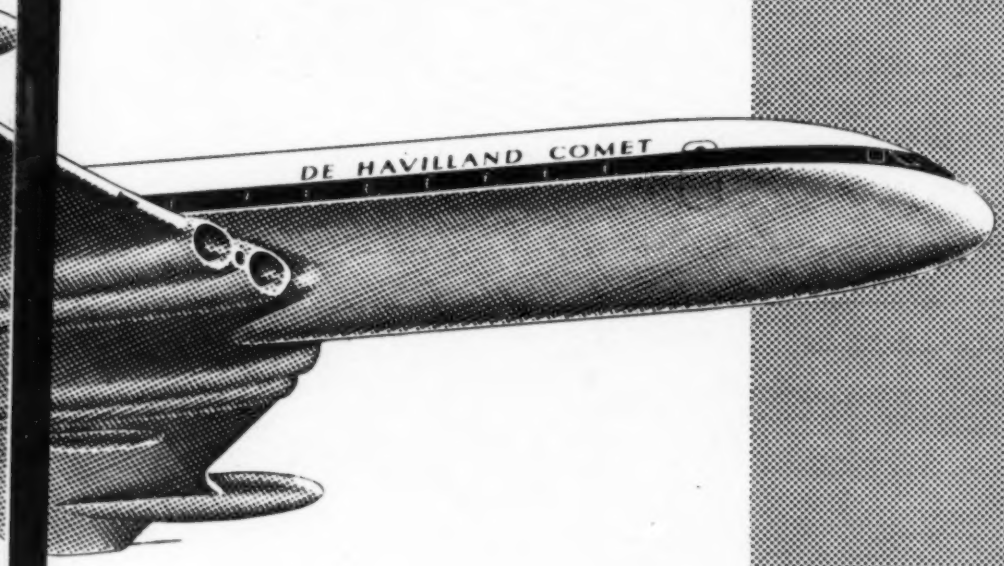
(Four Rolls-Royce Avon jet engines)

Master of the routes of moderate traffic density

D E H A V



Lunch in the Middle East



Entirely new standards of speed and comfort make jet travel irresistible.

The airline which operates jets will have the prestige, the passenger appeal, the revenue.

The new Comet is the only jet airliner in the world which is backed by a wealth of experience and development. Its Rolls-Royce Avon engines already have a million hours of service behind them.

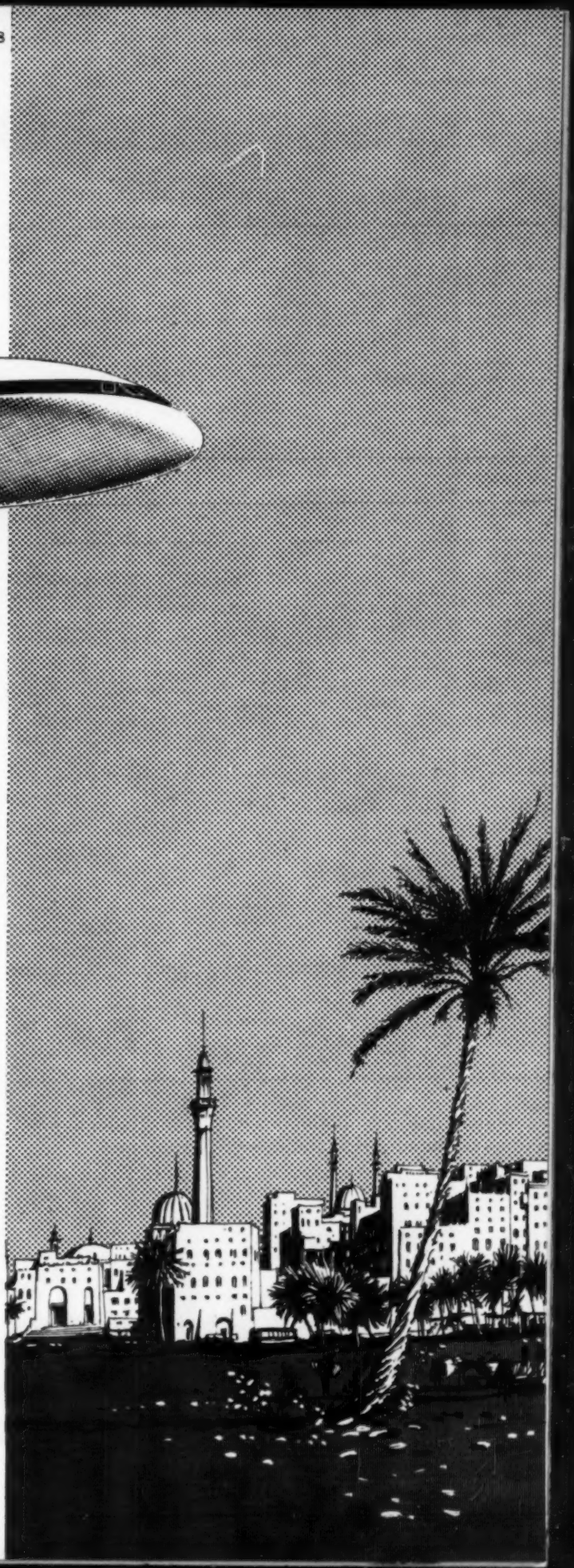
The Intercontinental Comet will be operating on the services of British Overseas Airways Corporation by 1959. It will carry its capacity payload, about 60 passengers with first-class seating or, if desired, up to 76 passengers with tourist-class seating, on stages up to 3,000 miles.

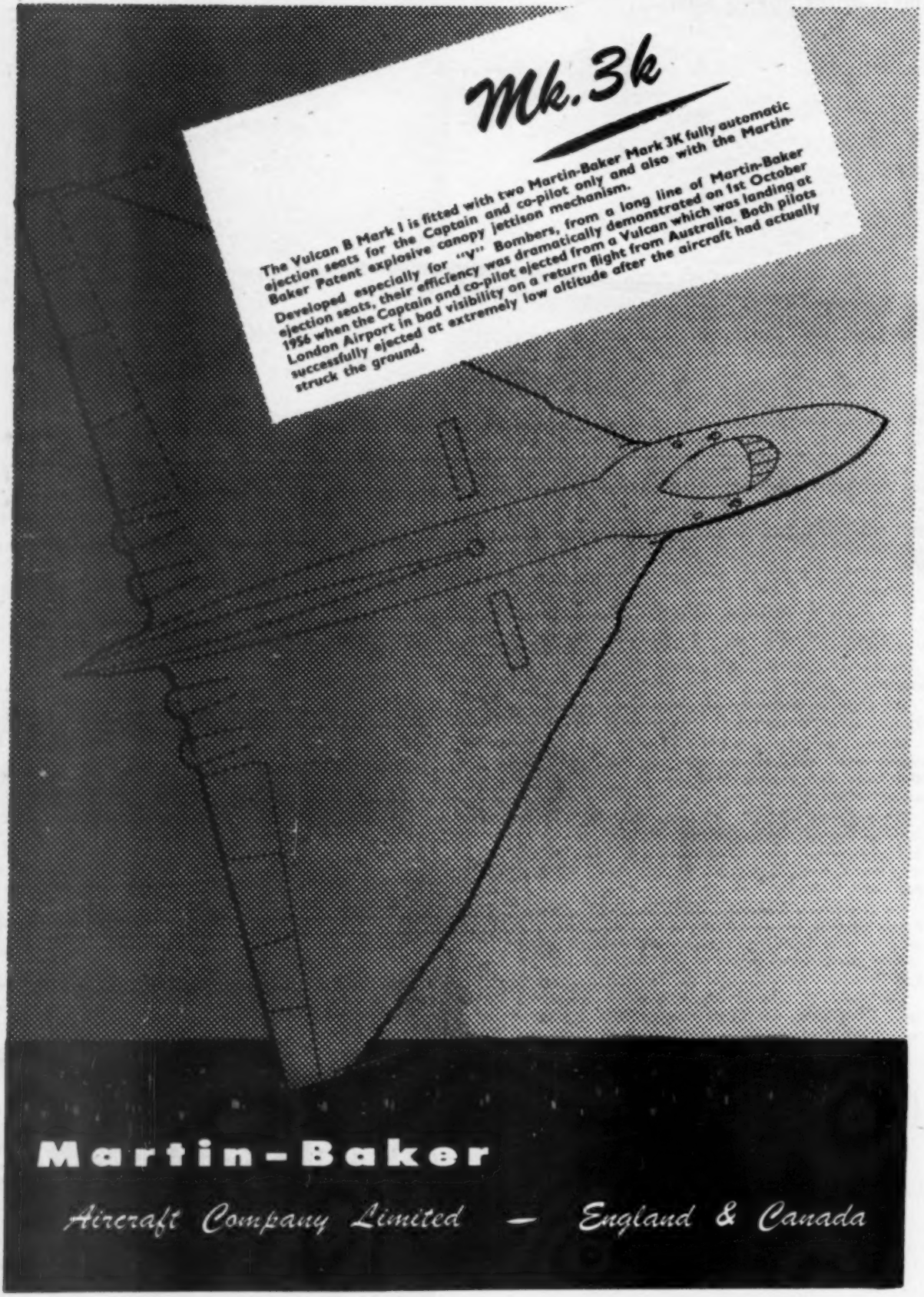
The Continental Comet will be operating on the services of British European Airways Corporation by 1960. This version will carry its capacity payload, about 84 first-class passengers or up to 99 tourist-class passengers, on very short stages and up to 2,000 miles.

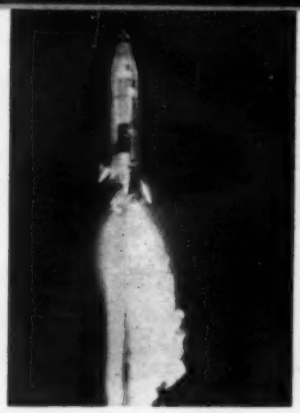
Both versions of the new Comet are specifically designed and developed to operate and pay their way on routes of moderate traffic density and from airports of moderate size.

—from 1959

I L L A N D

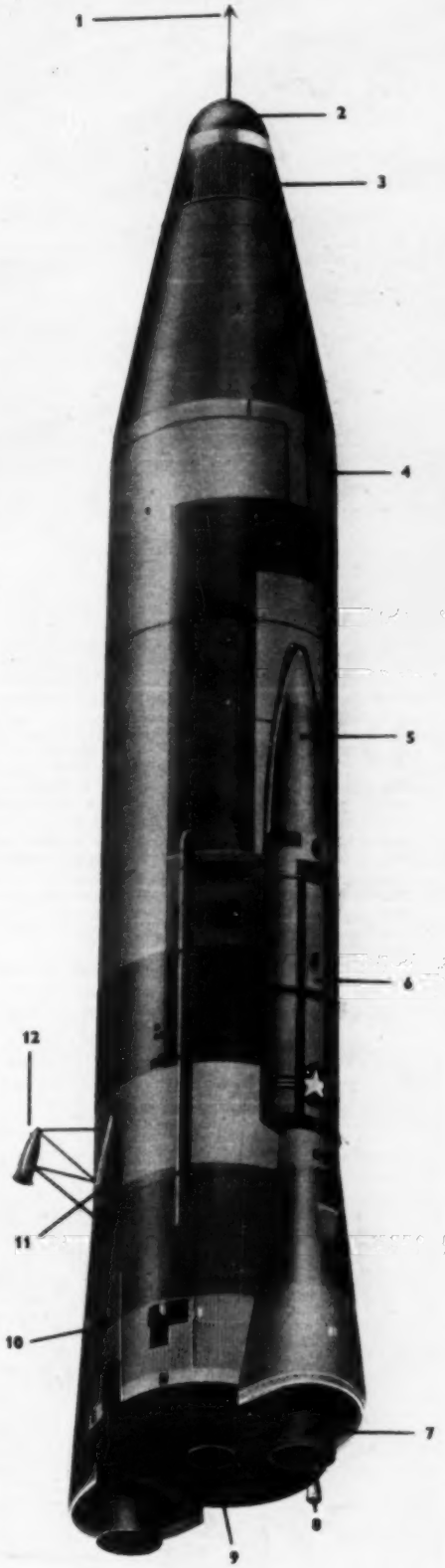



Mk.3k
The Vulcan B Mark 1 is fitted with two Martin-Baker Mark 3K fully automatic ejection seats for the Captain and co-pilot only and also with the Martin-Baker Patent explosive canopy jettison mechanism.
Developed especially for "V" Bombers, from a long line of Martin-Baker ejection seats, their efficiency was dramatically demonstrated on 1st October 1956 when the Captain and co-pilot ejected from a Vulcan which was landing at London Airport in bad visibility on a return flight from Australia. Both pilots successfully ejected at extremely low altitude after the aircraft had actually struck the ground.
Martin-Baker
Aircraft Company Limited — England & Canada



ICBM IN DETAIL

CONVAIR SM-65 ATLAS (WS-107-A-1). Pressurized thin-wall airframe forming integral tanks for liquid oxygen and kerosine, fed to two boost motors and one sustainer. Height, approximately 80ft exclusive of experimental probe; body diameter, about 9ft, or 15ft across fairings; firing weight, approximately 200,000 lb; re-entry speed, about Mach 15; design range 5,500 miles.



FURTHEST advanced in development of the 5,500-mile intercontinental ballistic missiles of the U.S. Air Force is the Convair SM-65A Atlas. Although our special missile issue of December 6 outlined the history and characteristics of this weapon, it is only now possible to present a detailed illustration. The following characteristics are noteworthy:—

(1) During the vertical climb through the atmosphere the relative wind is measured by this combined pitot/static head and yaw-meter. The sensing head is on an 8ft rod and probably includes thermocouples.

(2) For re-entry into the atmosphere the nose is blunt and smooth. The skin is likely to be a layer of dielectric material, with a thickness equal to half the wavelength of ICBM-detecting radars to reduce the return signal-strength. Inside is the thermonuclear warhead, probably a sphere some 6ft in diameter.

(3) The re-entry body separates gently from the propulsion section at some point after the cut-off of fuel. The skin is deeply corrugated—a compromise between electronic countermeasures and super-aerodynamics—and a subtle change in taper occurs at the transition ring.

(4) Almost all the airframe is a thin-walled cylinder, carefully made in high-strength light alloy by chemical etching and precision machining. Inside are housed some eighty tons of liquid oxygen and kerosine, in integral tanks which—so thin is the skin—are pressurized to preserve their shape.

(5) On either side of the body is a long fairing, the foremost part of which is occupied largely by electronics. The compartment is air-conditioned and pressurized and is covered by a flush dielectric door.

(6) Prime contractor for the guidance system is General Electric at Syracuse (Heavy Military Electronic Department), who have evolved a radio-inertial system involving a Burroughs computer. More than 200 cu ft of guidance equipment is contained in each of the lateral fairings. The covers are painted with the U.S. insignia and black lines for camera tracking.

(7) At the rear of each fairing is a single, gimballed-chamber boost motor, by North American Aviation's Rocketdyne division. The chambers are each rated at 165,000 lb thrust and are moved in unison by hydraulic jacks controlled by servos leading down from the guidance systems. At the end of the boost phase both units are jettisoned.

(8) Exhaust from the turbopumps feeding the three motors is discharged from this pipe. The pumps run on the main propellants, and turbine temperature is restricted by feeding an excess of fuel. This burns in the exhaust, forming an irregular cloud of flame (heading picture).

(9) On the axis of symmetry is mounted the sustainer motor. This has a gimballed chamber rated at 65,000 lb thrust and is likewise a Rocketdyne product. Owing to the unusual configuration of the Atlas the sustainer is fired on the ground.

(10) The ribbed skirt of the body is unpressurized, since it is relatively lightly loaded and does not contain fuel. Part of it is dropped off with the boost motors, leaving the sustainer completely exposed.

(11) At 90 deg to the boost packages are mounted two small vernier motors, the oblique flames from which may be seen in the photograph. The purpose of these motors is twofold: they provide accurate (vernier) control to establish the weapon on its precise ballistic trajectory after cut-off of the main sustainer, and they are gimballed to stabilize the missile about its roll axis.

(12) The fourth round fired—on January 10—carried this curious device, mounted on struts some five feet away from the body. It may be a camera; alternatively it could well be a radio aerial, mounted to transmit and receive signals without the latter being distorted by passage through the ionization of the motor flames.

It takes the best part of 24 hours to fuel an XSM-65 development round and conduct all the pre-firing checks. When ready to take off the weapon weighs some 200,000 lb, yet this is only about half as much as the available thrust, and the weight falls rapidly as the level of the propellants drops. The liquid oxygen, at minus 183 deg C, causes frost and ice to form over part of the body, but this crumbles and falls in a cloud during the first few seconds of flight. XSM-65s were fired on June 11, September 25, December 17 and January 10.

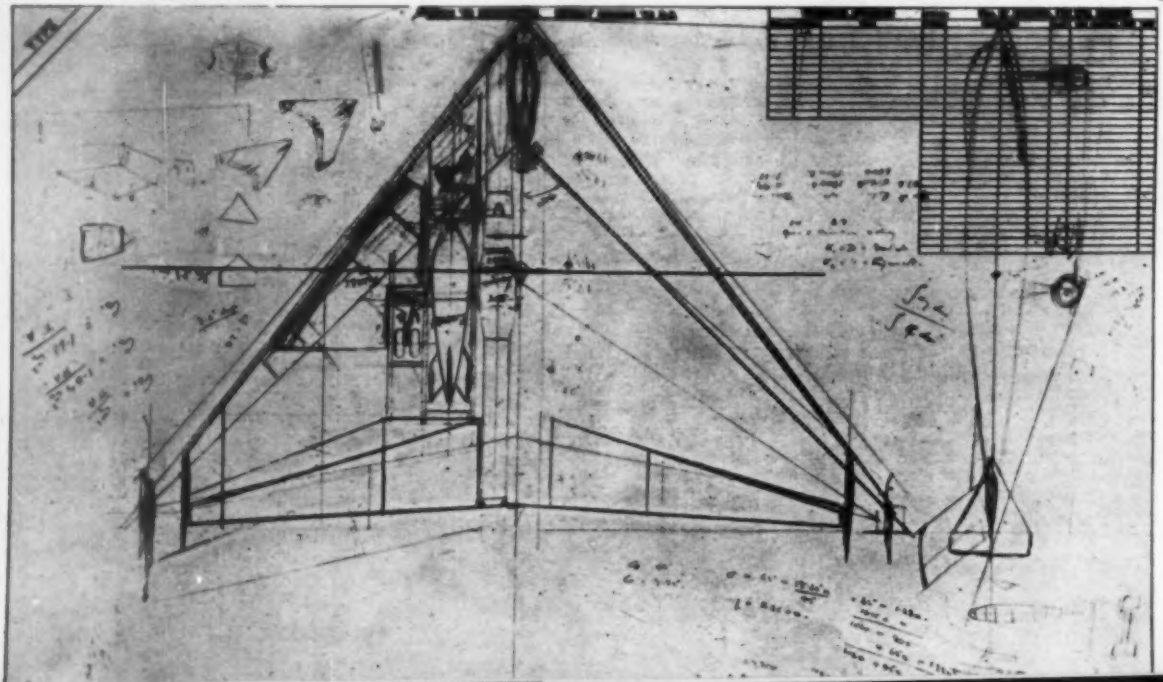
THE VULCAN STORY

DURING the Second World War A. V. Roe and Co., Ltd., one of the principal partners in the Hawker Siddeley Group, produced our finest bomber aeroplane, the immortal Lancaster. From it was evolved the Lincoln, which had even greater load-carrying ability coupled with a speed not far short of 300 m.p.h. and an operating altitude of well over 20,000ft. When we described the Lincoln in detail shortly after the war we said "on every count of assessment the machine comes nearer the ultimate than any other heavy bomber in the world." In view of the existence of the B-29 this may have been a generous appraisal, but it serves to emphasize how highly the Lincoln was regarded twelve years ago when it was new.

This being so, it is easy to appreciate the perceptive foresight and remarkable courage of the British Air Staff, who at that time had already formulated a requirement for a bomber having more than twice the Lincoln's speed and operating altitude, coupled with improved range and bomb-load. No one can truthfully say that our procurement of military aeroplanes during the past decade has been in any way a model of sound thinking, and it is therefore worth stressing that in 1946 the specification which ultimately resulted in the V-bombers was appreciably in advance of equivalent requirements in any other country. It is still not permissible to divulge the figures called for in this outstanding document, but it is clear that the specification posed a challenge so great as to be almost, but not quite, beyond "the state of the art."

Superimposed on the ambitious demands for performance

This historic sketch is believed to be the very first Avro 698 delta drawing. The "doodles" are by the late Roy Chadwick and his team.



Design and Development of an Outstanding British Bomber

BY THE TECHNICAL EDITOR

was a suggested limitation on gross weight. Strenuous efforts were being made at that time to stave off the evil day when the standard operating platform of Bomber Command would have to be lengthened and strengthened, and as runway loading index and gross weight were then considered to be directly related, it was desired that the latter parameter should be limited to a value —a remarkably low value—written into the specification.

At the beginning of 1947 the Air Ministry sent copies of the specification to selected bomber firms. One of these companies was A. V. Roe at Chadderton, between Manchester and Oldham, where the project was raised under the company number 698. It was obvious from the outset that no conventional aircraft could even approach the required performance; and the Avro design team, although one of the strongest in the country, was soon acutely conscious of the very limited knowledge which was then available on high-speed aircraft design. Virtually nothing worthwhile could be culled from the R.A.E. or the U.S.A., and almost all that the company had to go upon were the reports by the field team investigating German research during the 1939-1945 war.

These reports were the first to make widely known the reduction in high-subsonic drag which could be obtained by the use of swept-back wings. Avro investigated a number of possible configurations before deciding to concentrate upon a design which, although otherwise conventional, had a wing with 45 deg sweep-back at the quarter-chord line, a thickness/chord ratio of some 12 per cent at the root and a modest design lift coefficient. This seemed a good jumping-off point; but even the earliest calculations showed that any machine of this shape then capable of being constructed would have exceeded the target weight by 100 per cent, and would have failed to achieve the desired performance (it would have been generally comparable with the B-47). Avro's thinking next took the following lines: "a bomber carries a concentrated load and so the fuselage is needed only to carry the tailplane; since the swept wing increases longitudinal stability it may be possible to delete the tailplane and hence eliminate the fuselage also." Putting this idea into practice, the company arrived at an all-wing shape reminiscent of the Northrop aeroplanes of that time. Assessment of this showed a substantial reduction in gross weight, but one still insufficient to bring the weight down to less than 150 per cent of that officially suggested. It was clear that the wing itself (which now comprised virtually the whole airframe) was too heavy, and that the only practicable method of trimming its weight lay in a considerable reduction in aspect ratio. In effecting this the design team were increasingly attracted by the idea of filling in the gap between the wing tips and the fuselage behind the trailing edge, and thus producing the triangular delta shape. As soon as this was done the way was opened to the use of thinner material gauges and traditional manufacturing methods, which, advantageous enough in themselves, also came hand-in-hand with a very great reduction in wing weight. Moreover, although the thickness/chord ratio had not been increased, the interior volume of the wing had risen sufficiently to provide capacity for a much greater quantity of fuel. At last the Air Ministry requirements were within Avro's grasp.

An accompanying drawing shows the classically simple configuration of the original delta sketch. Within the wing, space was provided for an offset bomb load, two or four (upper and lower on each side) large turbojet engines and the main undercarriage, in addition to the bulk of the fuel. At the front was a rudimentary fuselage containing the crew compartment. The flying controls, which were based on those developed for the Armstrong Whitworth A.W.52, consisted of an unusual arrangement of double elevons along the wing trailing edge; fixed fins were provided at the wing tips. In spite of its radically new shape, the design seemed on paper to be logical and correct, and the late Mr. Roy Chadwick, then Avro's technical director, decided to back the delta proposal as his company's submission to the specification. His chief designer, Mr. S. D. Davies, later said "I would like to pay tribute to the courage of Mr. Chadwick in making the decision to back the tailless delta configuration. It is one thing for a junior technician to push an unconventional idea, but for a designer with Mr. Chadwick's past history of success to risk his reputation on such a venture was an act of high courage which was not perhaps sufficiently recognized."

A project model of the Avro 698 as it was late in 1948. Similarity to the present Vulcan is close, the latter differing only in detail.

This was the tender which Avro submitted in 1947, but before the Ministry of Supply accepted it the design evolved into the form shown in an accompanying photograph. The originally meagre store of knowledge of high-subsonic aerodynamics was steadily being reinforced with data from the U.S.A. and elsewhere. Towards the end of 1947 the Avro project staff realized that low thickness/chord ratio was just as valuable as wing sweep, and the wing of the 698 was thereupon reduced in thickness, albeit at the expense of greater structural loads. This reduction in thickness made it impossible to accommodate the powerplants (the projected Bristol B.E.10 two-spool engine) in superimposed pairs, and the upper engines were therefore relocated outboard of the lower units, each pair being served by wide slot-type intakes. The flying-control system was completely redesigned; the elevon arrangement was replaced by inboard elevators and outboard ailerons, and the wing-tip fins gave way to a single vertical surface on the aircraft centre-line. At the same time the fuselage was allowed to grow somewhat, thus removing any suggestion of all-wing appearance.

By January 1948 the Avro 698 design looked very much like the present Vulcan. In that month the Ministry of Supply awarded a prototype contract for the 698; an order had already been placed with Handley Page for the H.P.80 (the Victor).

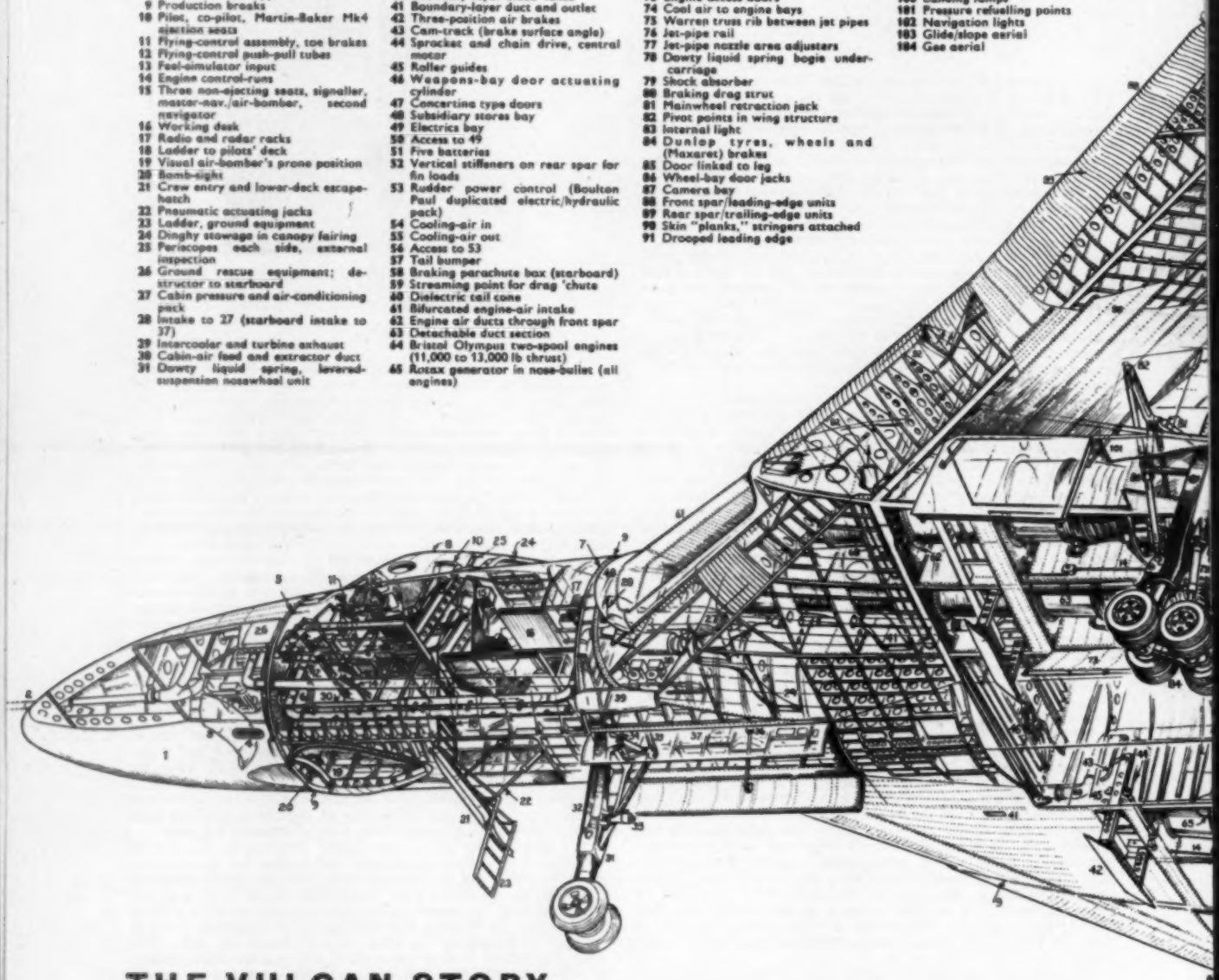
During 1948, tunnel-testing of the Avro 698 began in earnest. The tunnel programme was divided into low-speed and high-speed portions, the former being carried out jointly by Avro, the R.A.E. and the National Physical Laboratory, and the high-speed part being undertaken solely by the R.A.E., whose 11ft tunnel was at that time the only one in the country capable of handling such work. The following is taken from a paper prepared by Avro:

"As part of the high-speed model programme the R.A.E. investigated the effect of planform and section modifications on the characteristics of the aircraft at high subsonic speeds up to and above the design cruising lift coefficients. These tests indicated that substantial improvements in both the drag-rise critical Mach number and the drag rise with increase in lift coefficient could be realized by modifying the wing sections across the span. The reasoning behind these improvements was that the characteristics of a wing at high Mach numbers are closely related to the sweepback of the maximum-suction line, and this is adversely affected by root and tip effects. At the root the peak-suction line tends to become normal to the centre-line to attain continuity, and this causes a reduction in sweep over the inner part of the wing. At the tip the high induced incidences move the peak-suction line forward, again reducing its sweep. The R.A.E. therefore evolved a wing in which the maximum thickness of the wing sections was progressively moved forward from tip to root and the sweepback of the peak-suction line maintained over a much greater proportion of the span than on a wing of similar planform but with constant section throughout."

So advantageous were the effects of this modification that early in 1950 the 698 wing was redesigned to incorporate the R.A.E. recommendations. Although unchanged in planform, the new wing had a section which was progressively modified to bring the point of maximum thickness very near to the leading edge at the root; the flow in this area was in any case appreciably influenced by the fact that the inboard portions of the wing were occupied by the powerplants and their ducting. To some

KEY TO DRAWING

1 Dielectric nose 1.3ft x 8ft
2 Flight Refuelling probe
3 Radar scanner
4 Vent; cabin air discharge into bay
5 Front pressure bulkhead
6 Access hatch to nose
7 Rear pressure bulkhead, nosewheel beams on rear face
8 Jettisonable canopy
9 Production breaks
10 Pilot, co-pilot, Martin-Baker Mk4 ejection seats
11 Flying-control assembly, toe brakes
12 Flying-control push-pull tubes
13 Feel-simulator input
14 Engine control-runs
15 Three non-ejecting seats, signaller, master-nav./air-bomber, second navigator
16 Working desk
17 Radio and radar racks
18 Ladder to pilots' deck
19 Visual air-bomber's prone position
20 Bomb-sight
21 Crew entry and lower-deck escape-hatch
22 Pneumatic actuating jacks
23 Ladder, ground equipment
24 Dinghy stowage in canopy fairing
25 Periscopes each side, external inspection
26 Ground rescue equipment; de-structor to starboard
27 Cabin pressure and air-conditioning pack
28 Intake to 27 (starboard intake to 37)
29 Intercooler and turbine exhaust
30 Cabin-air feed and extractor duct
31 Dowty liquid spring, levered-suspension nosewheel unit
32 Magnesium-alloy casting
33 Breaker strut
34 Jack (4,000 lb/sq in system)
35 Steering cylinder (internal final drive) ±47.5 deg
36 Nosewheel door jacks
37 Equipment bay, hydraulics, pneumatics, electrics, electronics
38 Inverters (three)
39 Cooling air to 38
40 Boundary-layer bleed 'fence'
41 Boundary-layer duct and outlet
42 Three-position air brakes
43 Cam-track (brake surface angle)
44 Sprocket and chain drive, central motor
45 Roller guides
46 Weapons-bay door actuating cylinder
47 Concertina type doors
48 Subsidiary stores bay
49 Electrics bay
50 Access to 49
51 Five batteries
52 Vertical stiffeners on rear spar for fin loads
53 Rudder power control (Boulton Paul duplicated electric/hydraulic pack)
54 Cooling-air in
55 Cooling-air out
56 Access to 53
57 Tail bumper
58 Braking parachute box (starboard)
59 Streaming point for drag 'chute
60 Dielectric tail cone
61 Bifurcated engine-air intake
62 Engine air ducts through front spar
63 Detachable duct section
64 Bristol Olympus two-spool engines (11,000 to 13,000 lb thrust)
65 Rotax generator in nose-bullet (all engines)
66 Accessory group, pumps, fuel-cooled oil cooler
67 Engine mounting points
68 Compressor bleed ducts, anti-icing, cabin air
69 Firewalls
70 Fire-shrouds
71 "Alfol" covered jet pipes (app. 22ft long)
72 Jet-pipe heat shroud
73 Engine access doors
74 Cool air to engine bays
75 Warren truss rib between jet pipes
76 Jet-pipe rail
77 Jet-pipe nozzle area adjusters
78 Dowty liquid spring bogie under-carriage
79 Shock absorber
80 Braking drag strut
81 Mainwheel retraction jack
82 Pivot points in wing structure
83 Internal light
84 Dunlop tyres, wheels and (Maxaret) brakes
85 Door linked to leg
86 Wheel-bay door jacks
87 Camera bay
88 Front spar/leading-edge units
89 Rear spar/trailing-edge units
90 Skin "planks," stringers attached
91 Drooped leading edge
92 Thermal anti-icing ducts
93 Corrugated inner skin
94 Elevators
95 Ailerons
96 Power-control jacks (see 53)
97 Irving-type pressure-sealed balance (and mass balance)
98 Hinges on upper surface
99 Honeycomb sandwich inspection panels
100 Landing lamps
101 Pressure refuelling points
102 Navigation lights
103 Glide/slope aerial
104 Gee aerial



THE VULCAN STORY...

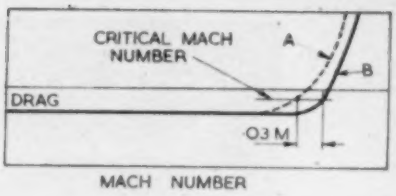
extent the modified surface can be described as a crescent wing (chosen by Handley Page for the H.P.80) contained within a delta planform, the latter giving increased area and easing the structural problems.

Summarized, the following were the other tunnel programmes in the initial stages: R.A.E. high-speed tunnel, fully representative model of the 698 and half-wing pressure-plotting model; R.A.E. low-speed tunnel, complete model with intakes; Avro low-speed tunnel, complete model without intakes, in addition to load and pressure measurements on canopies, bomb doors, undercarriage, airbrakes and similar components; and N.P.L. compressed-air tunnel, various tests over a wider range of Reynolds numbers than could be obtained in the other tunnels.

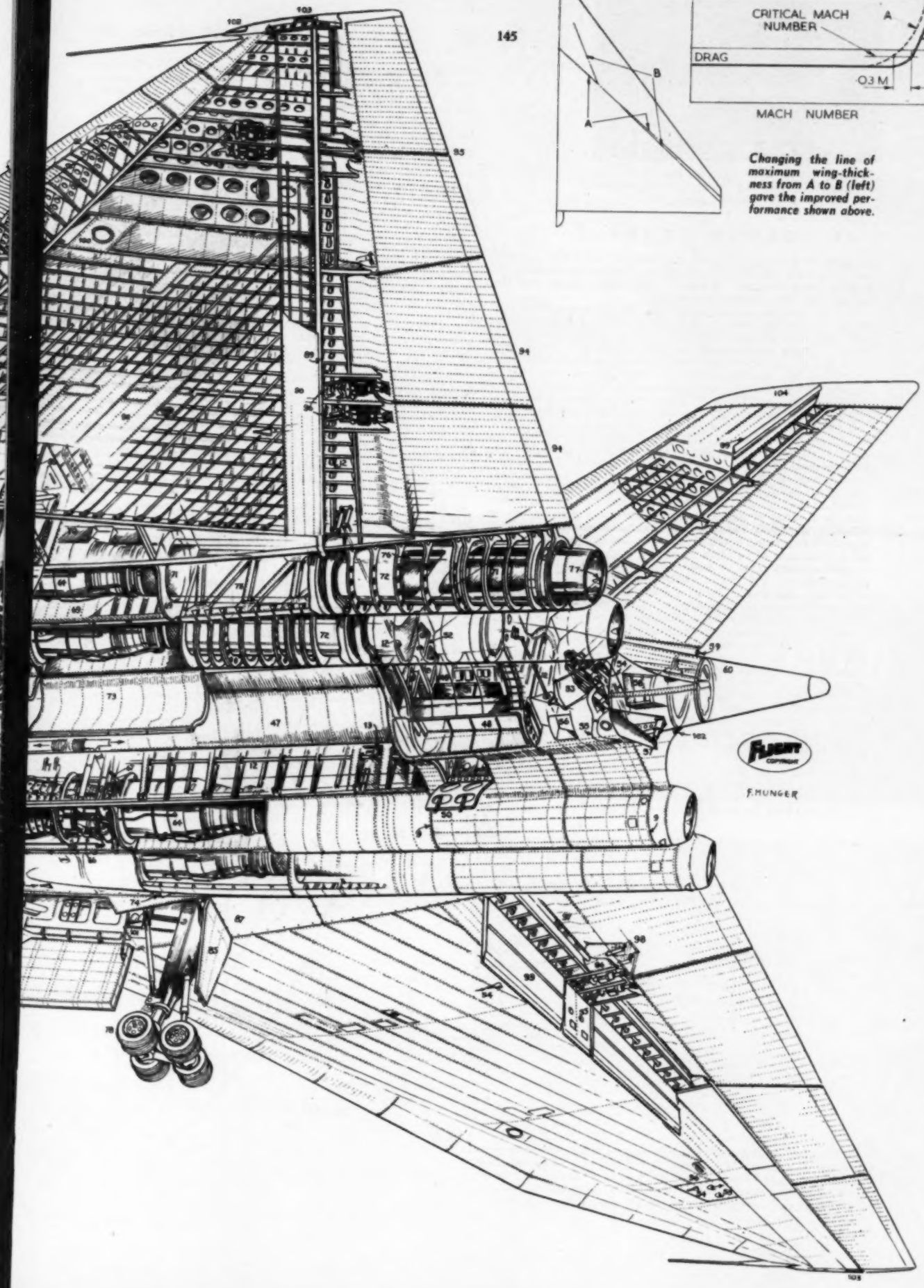
Long before the wing was finally settled Avro had embarked on a massive programme of basic aerodynamic research. Broadly speaking, the following were the principal questions posed by the new configuration: what was the maximum usable lift coefficient likely to be achieved by the full-scale wing; would the combination of low wing loading and low aspect ratio require exaggerated angles of attack at take-off and landing; would the stalling behaviour of the wing have serious effects on longitudinal stability; would the aircraft be unduly sensitive to c.g. travel, and what useful c.g. range would be achieved without a tailplane; and how would the aircraft fly when it was subjected to compressibility?

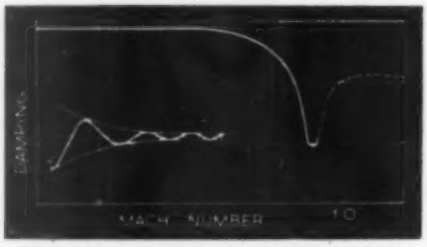
Most of the high-subsonic stability and control problems were quite capable of being settled by tunnel testing, but Avro felt that the crucial problem of unpredictable behaviour at take-off and landing could be properly resolved only by building a research aeroplane representing a scale model of the eventual 698. The project number assigned to the "miniature 698" was 707. Outboard of the fuselage the wing was a one-third replica of that of the 698 (retaining the original constant section), but power was

(*continued on page 146*)



Changing the line of maximum wing-thickness from A to B (left) gave the improved performance shown above.





A curve of pitch-damping, plotted from flight tests with the Avro 707A and 707B. Damping remains positive at all speeds.

THE VULCAN STORY...

provided by a single Rolls-Royce Derwent fed from a dorsal intake between the canopy and the fin. Unlike the bomber the controls were manually operated, with inset hinges, and the fuselage was proportionately oversize.

The 707 bore the serial number VX 784 and it was taken into the air for the first time by F/L. S. E. Esler on September 4, 1949 (and thus was the second delta-wing aircraft to fly in the world). During the following week the aircraft flew about three hours and the handling characteristics were proved to be quite satisfactory—in fact little different from those of conventional aircraft. It was exceedingly unfortunate that the aircraft crashed shortly afterwards, killing Eric Esler, but the cause of the accident was in no way traceable to the delta configuration.

It was at once decided to construct two further 707s. The first to be completed was the 707B (VX 790) which was flown by W/C. R. J. "Roly" Falk, Avro's superintendent of flying until the beginning of this year, on September 6, 1950. This aircraft likewise retained the original design of wing, with a constant t/c ratio of 10 per cent. It was, however, much modified in detail, having an ejection seat, elevator balance and modified airbrakes; later, as a result of flight tests, the intake was preceded by an N.A.C.A. divergent ramp to give improved pressure recovery. The 707B flew many hundreds of hours and has been responsible for a great deal of valuable research. With it Avro established a self-contained team at Boscombe Down to handle the delta research flying. VX 790 is still on the inventory of the R.A.E. at Bedford, and was in use as a research machine until 1956.

Chronologically later came the so-called "high-speed" machine designated 707A (WD 280). This aircraft was the first to be fitted with the modified wing section which had previously been found to be the optimum, the engine being fed through wing-root intakes and the peak-thickness line being swept forward at the roots. Another major improvement was the incorporation of spring-tab controls with internal sealed balances. W/C. Falk flew WD 280 on July 14, 1951, and thereafter hundreds of hours of intensive testing laid the bogey of pitch-damping once and for all. The aircraft was retro-fitted with fully powered irreversible controls on the elevators and ailerons and has now completed well over 500 research flights. The aircraft is still actively flying, in Australia.

So valuable was the 707A that Avro manufactured two more 707s with virtually identical wings and control systems. The first was WZ 736, which was almost a straight copy of WD 280. This aircraft was built for the R.A.E., who employed it in the development of an automatic throttle system. The second was a side-by-side two-seater designated 707C (WZ 744), which was used by the A. and A.E.E. at Boscombe Down as a general appreciation and pilot-familiarization aircraft. The 707C has also been used for comparative gun-aiming trials and is now engaged in the development of a new control system for the I.A.P. department of the R.A.E.

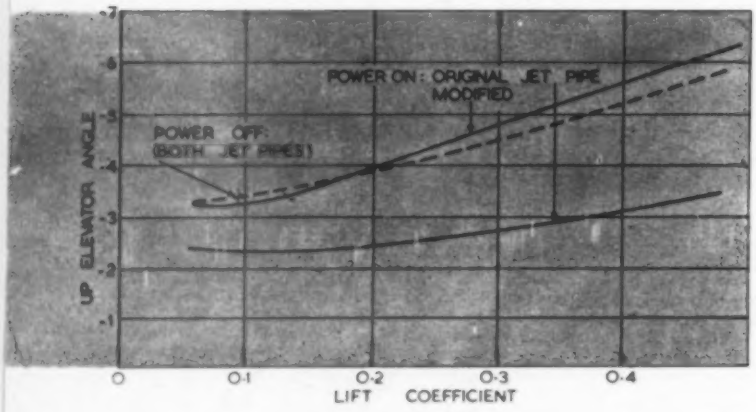
Between 1949 and the first flight of the prototype 698 in August 1952 the experimental data obtained with the 707s indicated that the delta configuration was perfectly satisfactory under all flight conditions; in fact, the 707 has been described as "considerably more docile than current swept-wing aircraft of medium aspect ratio."

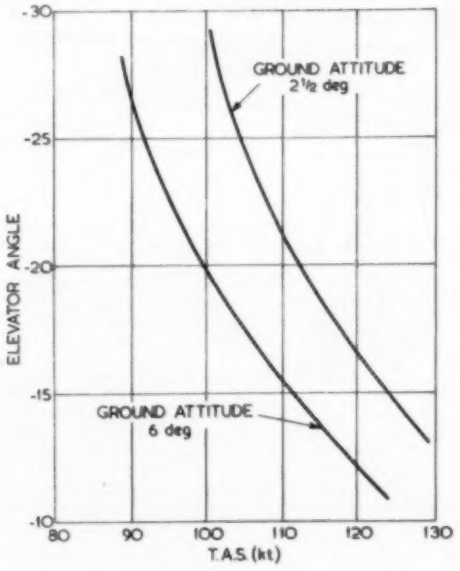
An accompanying set of curves show that the damping of short-period pitching oscillations is always positive. Admittedly the damping falls to a minimum at a Mach number slightly above the design cruising value for the 698, but at no point does it become unsatisfactory and it increases again as sonic velocity is reached. On the 707B an undamped pitching oscillation which did manifest itself was traced to an out-of-phase elevator motion just sufficient to produce a destablizing pitching moment. This undesirable phenomenon was almost eliminated by the spring-tab controls of the faster 707A, and the irreversible controls of the 698 obviated its occurrence on that aircraft.

Typical of the type of characteristic uncovered by the 707 aircraft which might otherwise have remained undetected was the precise relationship between wing incidence and the speed at which the nosewheel could be raised from the ground during the take-off run. As originally built, the 707B had to reach a speed almost equal to the take-off value before the nosewheel could be lifted clear of the runway, which then caused the aircraft to jump off the ground abruptly. This shortcoming was alleviated by increasing the wing incidence during the ground run by lengthening the nose leg, whereupon it became possible to lift the nose at less than 80 per cent of the unstick speed. Had the 707B not been built, a major modification to the 698 would undoubtedly have been necessary.

Another important effect investigated with the 707B was that, by suitably adjusting the line of action of the propelling nozzle, variation of longitudinal stability and trim with engine thrust could be virtually eliminated. By this time the 698 had intakes parallel with the leading edge (as shown on p. 143, the intake was originally well forward) yet even this aft intake location was appreciably ahead of the c.g. and the vertical component of the intake momentum drag produced a considerable nose-up change in trim. Accordingly the inboard jet nozzles were angled downwards through between 4 and 5 deg until change in power had almost no effect on trim. At the same time the outboard nozzles were turned through the same angle and also rotated, so that the thrust lines of the outer engines passed no further from the c.g. than those of the inners. By this means a worthwhile reduction in engine-out speed was achieved, the yawing moment of an outer engine being made the same as that of an inner. This in turn permitted a reduction in the size of the vertical tail.

One of the most remarkable characteristics of the subsonic delta wing developed for the 698 was found to be that, when its angle of attack was progressively increased, no sudden loss of lift occurred, as is suffered at the stalling point of a conventional





As described in the text, the jet-pipe nozzles of the Vulcan were turned slightly to minimize trim changes due to variation in engine power. The curves above were originally plotted from 707 flying. On the right are comparative curves, actually for the 707B, indicating the reduction in nosewheel-raising speed resulting from a lengthened nose leg.

Two years' service with the Royal Air Force has established the Jet Provost ab initio/basic trainer as the best aircraft for its purpose, and the Mk 3 powered by one Armstrong Siddeley Viper Turbo Jet is now in production for the re-equipment of Flying Training Command.

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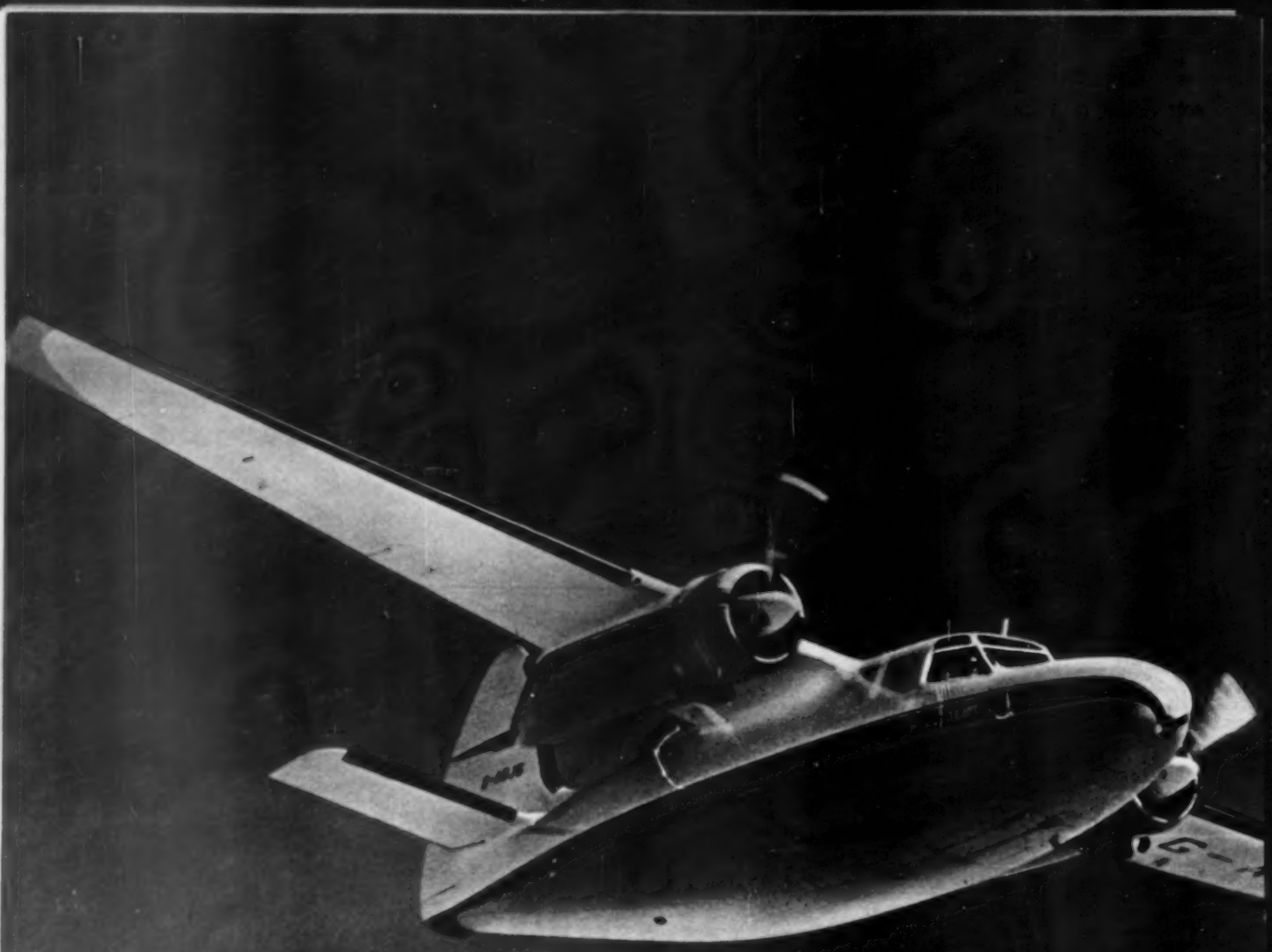

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wing. Tunnel testing with the 707 was conducted at angles of attack up to 60 deg, and even at this fantastic inclination the lift was still approximately 90 per cent of the maximum value. The stall itself was found to take place at around 28 deg, and to have little significance so far from the operating range.

Available range of c.g. was found to be about eight per cent of the mean chord, the aft limit being set by the longitudinal stability and the forward limit by the difficulty experienced by the pilot in raising the nose during take-off. Owing to their different control systems the aft limit for the 707A was not the same as it was for the 707B, but both aircraft have been flown quite satisfactorily with negative static margins. Avro's chief aerodynamicist, Mr. Peter Sutcliffe, has pointed out that "eight per cent may not seem a large range, but it must be remembered that the mean chord of the wing is much greater than that of the corresponding conventional wing of medium aspect ratio, and that the actual c.g. range in terms of distance is in line with normal values."

Even after the first 698 had flown, the value of its miniature counterparts—the 707A in particular—in no way decreased. The small research aircraft were found to be capable of collecting data much more rapidly than would have been possible with the 698 itself, and it was found that, after making the necessary corrections, 707A data could be applied to the 698 with a very high degree of accuracy. For example, a major modification to the wing—which is described later—was initially proven on the 707A and incorporated in a developed form on the 698.

This brings the story up to the roll-out of the first prototype Avro 698—which was thereupon named Vulcan—and its subsequent first flight at the company airfield at Woodford, Cheshire, on August 30, 1952, in the hands of "Roly" Falk. The serial number of this aircraft is VX 770 and it has always been distinctively finished in glossy white paint.

Owing to the unavailability of the Bristol B.E. 10 (which by this time had been named Olympus*), VX 770 was initially fitted with four 6,500 lb-thrust Rolls-Royce Avons. The aircraft performed admirably from the outset, and a mere two days after its first flight Falk flew it into the Farnborough Show—where, as we reported at the time, "it stole the show and opened the eyes of the world." VX 770 has now flown many hundreds of hours, and was later fitted with 7,500 lb-thrust Armstrong Siddeley Sapphire engines; it is now flying with Rolls-Royce Conway by-pass turbojets of almost three times the original thrust.

On September 3, 1953, the aircraft was joined by its sister ship VX 777, powered by four Bristol Olympus 100-series engines and thus almost representative of the production aircraft. Compared with VX 770 the second prototype has a fuselage a few inches longer to obviate the necessity of shortening the nose undercarriage before retraction. Both prototypes were built in the experimental shop at Chadderton, using full jigging for certain airframe portions and a large number of production tools. They were then taken by road to Woodford, as a photograph in our issue of April 25, 1952, suggested.

**Described in our issue of December 9, 1955.*

Taken in the autumn of 1951, this photograph shows a fully representative Avro 698 model in the 11ft R.A.E. high-speed tunnel.

The first "high-speed" Avro 707A, which flew in July 1951.

It is not yet permissible to publish a full description of the Vulcan, but a great deal may be said to outline the characteristics of the aircraft before once more taking up the thread of development.

Structurally the Vulcan is remarkably conventional, but its unusual shape has complicated the sub-division of the airframe for production convenience. Much the largest component is the centre section, in the form of a rectangular box joining the port and starboard wings and housing the weapons bay and powerplants.

Basically the wing is built on principles forming a logical extension of those used in the Lancaster, there being two main spars and no particularly unusual features. In the centre section the spars are joined by massive bridge pieces separated by the length of the weapons bay. Above the weapons bay there is no major structure and so frontal area has been reduced to that of either the fuselage or wing but never both together. The main load-bearing structure in the centre section comprises the front and rear spars, which are continuous from port to starboard, together with three ribs on each side which partition off the powerplants. Almost the whole underside in this area is formed from detachable panels or doors, and so major loads are carried around this region through the spars; nevertheless, loads over the upper surface are largely carried across the upper skin and bomb arches.

Although it obviously may not be described in detail, the weapons bay is clearly a single capacious volume occupying almost the full section of the fuselage and closed by two pairs of folding doors. Ahead of the bomb-bay is the fuselage fuel area. At the forward end of the tankage is a flat vertical bulkhead carrying the nose undercarriage and forming the rear pressure bulkhead of the crew compartment.

Of circular section, the crew compartment is pressurized by engine bleed. The structure comprises channel-section formers and stringers of top-hat section, together with four heavier longitudinal members. A jettisonable canopy is mounted above the flight deck and on the undersurface is a streamlined blister for the bomb aimer. Behind the latter is the powered entrance door which creates a dead-air region for the emergency exit of the three crew members on the lower deck. The forward pressure bulkhead is a convex pressing with a central hole for ground access to the large radar equipment mounted in the extreme nose. The whole undersurface of the latter is a radome made by Avro of dielectric sandwich material. The rear fuselage is a relatively rudimentary structure of light stringers and skin, housing the rudder power units and braking parachute and carrying further radar devices within a dielectric tail cone.

Each wing is a basically triangular structure bordered by the spars, with secondary leading and trailing edge assemblies. The leading edges are required to have high dimensional accuracy and surface finish and are accordingly constructed in envelope jigs, as shown in our issue of December 13. The leading-edge ribs are located perpendicular to the front spar, and the interior of the profile contains a contoured corrugated section leaving chordal passages for de-icing air. Each leading edge carries considerable torsional loads.

Manufactured at Woodford, the main inter-spar triangular box of each wing contains closely spaced ribs, each perpendicular to the hinge-line of the control surfaces. Six of the ribs in each wing are reinforced to carry the control surfaces and provision is also made for a considerable quantity of fuel within the wing, although details of this may not be published. A high proportion of the structure is in high-strength light alloy, the manufacture being described in a special article on December 13. The skin is applied in strips, shown in the drawing on pages 144-5, arranged parallel to the front spar. These are reinforced by extrusions of D.T.D.683 which are joined to the tops of the ribs by tiny forged links.

Metal honeycomb sandwich is employed around the cut-outs for the main undercarriage boxes and for the shrouds ahead of the

THE VULCAN STORY . . .

control surfaces aft of the rear spar. On the undersurface the shrouds are hinged to the spar and can be opened for access to the controls.

Design and manufacture of the fin, rudder, ailerons, elevators and bomb-doors was subcontracted to Armstrong Whitworth Aircraft. The vertical tail has spars and major ribs of high-strength light alloy and skins of hot-formed magnesium (attached by 5-per-cent magnesium rivets). Like the wing, the leading edge is of double-skin construction to provide passages for hot air; and the tip of the fin is a dielectric aerial. Each wing carries duplicated elevators and ailerons each with a strong spar of light alloy (and a light-alloy nose skin extended forwards to provide balancing) and a relatively light rear structure of magnesium alloy.

Only the barest details may be given of the Vulcan's accessory systems. One of the major contractors is Rotax, who provide 160 components on each Vulcan B.1, including the four engine-driven D.C. generators and the four 45 h.p. starters. The associated company of Joseph Lucas (G.T.E.), Ltd., manufacture the fuel and combustion system. The hydraulic system is energized by three Dowty Vardel 4,000 lb/sq in pumps and serves the undercarriage, bomb doors, steering and wheel brakes (the air brakes are worked by Rotax actuators).

Responsibility for the undercarriage was vested in Dowty Equipment, Ltd., and the following description of their contribution has been prepared by the company's managing director, Mr. E. Nicholl, who was largely responsible for the design:

"With an aircraft the size of the Vulcan, the first problem in undercarriage design is to work out a tyre arrangement which will avoid overloading the runways specified by the Air Ministry. The most practical solution to this, particularly with the ground clearance required by the Vulcan, is a bogie; but within the bogie it is possible to have some variation in tyre size.

"So far as wheel and tyre weights are concerned, it is an advantage to have a multiplicity of small wheels rather than a few large ones, and on investigating the Vulcan bogie design, it was found advantageous to use four wheels each carrying twin tyres, in preference to larger single-tyred wheels. On balance the undercarriage weight was increased due to the structure being longer, though there was a saving on the bogie beam because its length was reduced. Overall, however, the weight was lower with the small twin-tyred wheels.

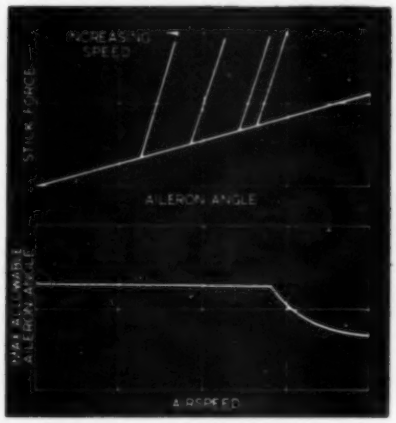
"The next problem was that of avoiding a fault observed with some earlier bogie undercarriages—porpoising on landing, that is, a pitching oscillation of the bogie. It was decided that this oscillation arose from the fact that the front tyres struck the ground with substantially increased velocity, and their undamped recoil initiated the motion. It was known that this could be overcome by applying the necessary damping, but it was thought that a simpler solution which was inherently stable could be achieved. From this resulted the design used on the Vulcan, in which pitching of the bogie on impact of the rear wheels takes place about the axis of the front wheels, giving no increase in the vertical velocity.

"This design has proved very successful and at no time has shown the slightest trace of porpoising. The arrangement is interesting in that all vertical loads are taken on a single pin-jointed shock absorber attached to the centre of the bogie beam, and that the large telescopic unit attached to the front of the beam deals only with resistance to drag and torsional forces. During retraction the bogie is trimmed so that the beam lies approximately horizontal in the wing section. This is done by 'shortening' of the main telescopic member, which requires only a very small jack. Re-extension of the member when lowering the undercarriage is obtained by an air cushion on the other side of the jack-piston.

Powerplant of every production Vulcan is the Bristol Olympus two-spool turbojet, with ratings from 11,000 to over 16,000 lb thrust. This is a 100-series engine (up to 13,000 lb thrust) at R.A.F. Waddington.

SIR ROY H. DOBSON
Managing director

J. A. R. KAY
Director and general manager



Characteristics of the aileron system on the Vulcan B.1: above are curves of stick-force against surface-deflection and maximum allowable deflection against I.A.S.

"Structurally the most interesting feature is the very large magnesium-alloy casting [by Sterling Metals] which provides the main strut for the bogie. Very careful consideration was given to alternative methods of construction in order to achieve the lightest weight, and it was concluded that, due to the large box-section available, a magnesium-alloy casting offered the best solution. These castings require a minimum of machining and have proved very reliable in service; but to maintain their weight advantage over other forms of construction, careful weight control by the foundry is essential.

"On high-speed aircraft the undercarriage doors have to be of rigid construction and carefully locked closed in order to avoid any gaping. This feature has enabled us to avoid the use of uplocks on the undercarriage, as the doors are well able to sustain the undercarriage weight. This results in a saving in weight on the uplocks and a simplification of the hydraulic system. The shock absorber is a Liquid Spring.

"The nose unit has twin wheels, rigidly coupled. Although this feature is not theoretically essential to the suppression of shimmy, it is considered most desirable because of the large number of factors which may initiate shimmy and of whose value we are still in ignorance.

"A large magnesium-alloy casting is used for the main strut, other components being mainly aluminium alloy, apart from the Liquid Spring shock absorber. Centering of the wheels is provided by a small hydraulic jack which is permanently pressurized, A steering jack is fitted which overcomes the centering jack when operated, and steers to an angle of 45 deg either side of the centre-line. This permits the aircraft to turn in a circle having a centre 12ft from the inner bogie; a tighter radius of turn is liable to cause serious damage to the tyres. Transmission of the steering signals from the pilot is electrical, using potentiometers and a sensitive relay which operates an electro-hydraulic valve."

All wheels, tyres and brakes are by Dunlop. Each of the eight main wheels carries two tyres, each normally provided with a dimpled tread. Although Dowty have experimented with shoe-type runway brakes for the Vulcan bogie, the standard pattern has conventional disc brakes operated by either of two independent hydraulic systems and controlled by foot pedals and Maxaret anti-skid units. All three undercarriage units can be lowered in emergency by *ad hoc* pneumatic systems operating the main and nose units independently. Magnesium Elektron give the aggregate weight of the three legs and ten wheels as 2,296 lb unmachined or 1,644 in the finish-machined condition.

SIR WILLIAM FARREN
Technical director

THE LATE ROY CHADWICK
Technical director until 1947

S. D. DAVIES
Chief designer until June 1955

J. R. EVANS
Chief designer

ROLY FALK
Superintendent of flying until this month

J. O. HARRISON
Chief test pilot

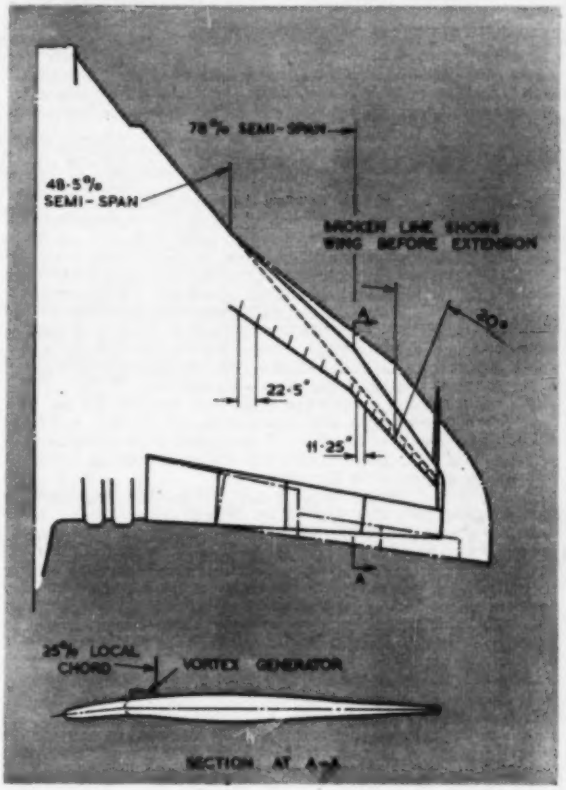
As already noted, the Vulcan is fitted with fully powered and irreversible ailerons, elevators and rudder, each surface having Westland-Irving sealed balances. The powered flying-control circuits are designed and produced by Boulton Paul. Both ailerons and elevators are divided into inner and outer portions, each section being operated by its own power unit to provide complete duplication. The rudder is similarly operated by a main and auxiliary power unit mounted together in the rear fuselage. All three types of unit are basically similar and comprise a Rotax D.C. motor, a hydraulic generator and ram and a differential lever assembly. Control movements from the cockpit are taken to the power units via push-pull rods.

Artificial feel is necessary in any fully powered system, and, although all three axes are treated separately, the usual arrangement is to use a "banana" lever to vary the gearing from the pilot to a double-acting coil spring as a function of indicated airspeed. The elevator circuits have q-feel, a pre-load spring being inserted to overcome static friction and centre the circuit. Turning to the ailerons, to avoid excessive aileron power at high speeds a box is fitted which limits aileron angle by mechanical stops as a function of $(I.A.S.)^2$; this circuit begins to restrict movement at a speed of the order of 290 knots. With regard to the rudder, this surface is virtually not needed once the aircraft is "clean." Accordingly, the only requirement is that the pilot should not be able to overstress the fin, and much response work was plotted in the form of allowable rudder angle against airspeed. It was found that pedal force per degree should be made a function of $(I.A.S.)^3$, so that at high indicated speeds pedal force may be twenty times that required for the same displacement at low speeds.

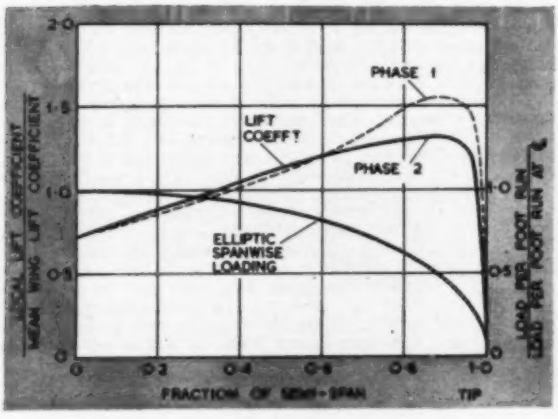
A further adjunct to the control system is an "automatic Mach trimmer" which Avro devised for the Vulcan and turned over to Louis Newmark, Ltd., for engineering and manufacture. This device counteracts the rearward shift in centre of pressure that occurs above a given high Mach number, a differential up-elevator movement being introduced relative to the pilot's control column so that a push-force is always required to increase flight speed. The correction falls away as altitude is reduced, and the output from the trimmer is accordingly monitored with static pressure and reduced as the latter rises. For this equipment Avro devised a method of shaping the transmission from the Machmeter to control the trimmer.

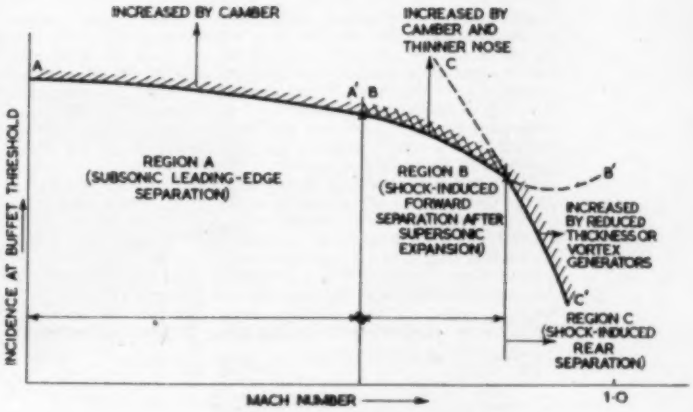
Avro have gone to exceptional lengths in proving all the Vulcan systems and doing their utmost to make failure impossible. In all cases analogue computers have been extensively used to clear each system at Chadderton before flight. The auto-Mach-trimmer is a typical instance of this policy. It is always in operation and could clearly cause serious trouble were it to run away under conditions of high V and low altitude. Avro have accordingly inserted a g-senser which isolates the trimmer circuit at a given flight acceleration so that, in the event of a run-away, the over-swing never takes the aircraft structure beyond its design limit. An additional item of equipment in the control system is a yaw damper.

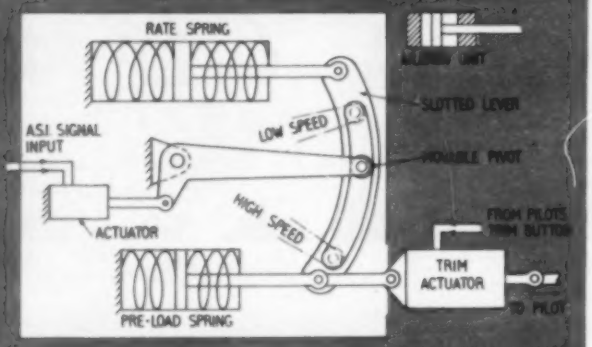
Air brakes are fitted above and below the centre section. The



The three diagrams on this page outline the Phase 2 wing modification. Above are plotted profiles for the original 698 wing, the Phase 2 (B. Mk 1) wing and the Vulcan B.2, the latter being a chain-dotted line. Below are the three types of separation causing buffeting and below left are curves showing the improvement obtained in spanwise lift-coefficient distribution. The Phase 2 wing was flown on a 707A.







Above is a schematic diagram of an elevator or rudder artificial-feel unit. The inset (aileron unit) replaces the double-acting rate-spring by mechanical stops. On the right are elevator and rudder feel-curves.

THE VULCAN STORY . . .

original 707B had simple upward-hinging plates, but the 707A pioneered the type finally chosen, in which rotating surfaces are mounted on perpendicular arms which move vertically out from the wing. Incorporation of this design in the Vulcan was complicated by the increased number of moving parts and the reduced stiffness of the surrounding aircraft structure. There are three brake positions: shut; medium drag (open and slightly rotated); and high drag (fully rotated), the last position being obtainable only with the undercarriage down. Although relatively small, these brakes have an extraordinary effect, adding two and a half times the profile drag of the clean aircraft.

All the foregoing factors had been fully resolved by the time that the first prototype was received by the A. and A.E.E. at Boscombe Down late in 1955. Nevertheless, a year previously a characteristic had been discovered which eventually led to a valuable modification to the wing.

It was found during tests on the 707A (WD 280) and the Vulcan prototypes that application of g at high altitudes could generate minor buffeting. Although in no way serious, it was sufficient to pose a fatigue problem in the outer wings. Continued investigation in flight showed that the buffet regime became uncomfortably near the performance boundary predicted for later versions of the Vulcan with more powerful engines. Accordingly the 707A and Vulcan prototypes were subjected to g loadings to produce high angles of attack, which were then extrapolated to simulate the behaviour of the developed Vulcan at its much greater operational altitudes.

It should be emphasized that the buffet threshold is the point at which disturbance first becomes perceptible; the vibration experienced is, for example, much less than that caused by starting the piston engines of an airliner. Avro, the R.A.E. and the N.P.L. attacked the problem along a broad front and investigated the basic causes. A diagram on the previous page illustrates the three different factors causing the flow to separate from the upper surface of the outer portion of the original Vulcan wing.

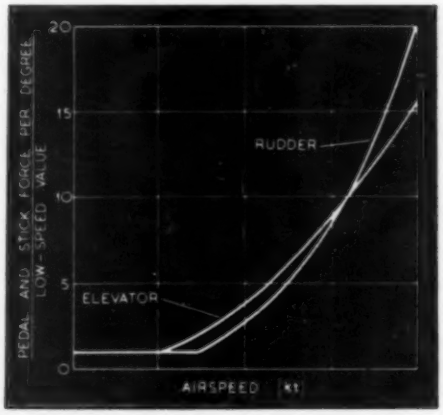
At low to medium Mach numbers, the region A (in the diagram) experienced what approximates to a conventional stall. As the Mach number was increased it was found that the presence of shock waves close behind the leading edge were a further cause of separation, notwithstanding the existence of supersonic expansion around the leading edge itself. At a still greater Mach number the sonic region progressed back across the wing and the separation followed the pattern illustrated at C. In Avro's words:

"One basic factor affecting the incidence at which separation occurs is the ratio of the peak local lift coefficient near the tip to that of the wing as a whole. On the basic Vulcan the high taper ratio and the elliptic load distribution combine to give a peak value of this ratio at 1.56. It has been found, however, that small variations in planform do not affect the basic elliptic loading of the delta wing, and therefore any extension to the chord near the tip is directly effective in reducing the local lift coefficient. The leading-edge modification consists of a 20 per cent chord extension over the outer 20 per cent of the wing, this extension reducing to zero at about 50 per cent semi-span. The effect is to reduce the peak lift-coefficient ratio to about 1.3, and this can be regarded as a direct increase in the incidence at the buffet threshold of about 20 per cent.

"However if full benefits are to be gained in all three regions then a combination of the planform change with other modifications is required. The subsonic separation of region A can be delayed by a greater radius of curvature on the upper surface near the leading edge, and this has been done by drooping the extended leading edge. Unfortunately a drooped extension of this type also delays the formation of the supersonic expansion which is beneficial in region B, and this has been promoted at an earlier incidence by sharpening the leading edge. Neither of these modifications really affects the onset of rear separation and here the fundamental cure would be a reduction in sectional thickness ratio. It has, however, been found that vortex generators will re-energize the boundary layer sufficiently to give a substantial gain in the lift coefficient at separation in region C."

Flight trials of the modified wing were conducted with a 707A and the modification was thereupon transferred to the Vulcan itself early in 1955. The modification was confined to the first 12½ per cent of original wing chord.

A number of production B. Mk 1 aircraft had been completed when the revised wing was introduced, but all were speedily brought up to the new configuration (which was designated Phase 2). The first Vulcan B.1, XA 889, was delivered to Boscombe Down for preliminary acceptance trials shortly before Easter 1956, and it was checked out within a month. Initial acceptance thus occurred nine years five months from the receipt of the specification, and three years seven months from the first flight. Three months later, in August 1956, the first delivery was made—to No. 230 Operational Conversion Unit at Waddington, Lincolnshire.



Operational Vulcans with Bomber Command are assigned to No. 1 Group, and squadrons already named as recipients include Nos. 83, 101 and 617. The performance of the aircraft in service has been truly outstanding—except for a singularly unfortunate electronic malfunction during the S.A.C. bombing trials at Pinecastle A.F.B., Florida—and in our first appraisal of the aircraft through the eyes of the R.A.F. (*Flight*, September 27, 1957) it was remarked that its utilization rate was better than that of any other machine in Bomber Command, large or small.

Production Vulcans have been successively fitted with Olympus engines rated at 11,000, 12,000 and 13,000 lb thrust. From the earliest days, however, the overall powerplant installation has been suitable for units with a thrust of up to 16,000 lb, and this is the initial type-tested rating of the Olympus 200, or BOl.6, which is in production for the Vulcan B. Mk 2. The Olympus 200 is a quite outstanding engine, and was discussed in our issue of February 15, 1957. In order to utilize the substantial increase in power from this engine, Avro had to conduct a major airframe redesign, the full ramifications of which will become slightly more apparent when the first B.2 flies later this year.

It is possible to comment on the wing of the new Vulcan, since this has been fitted to the second prototype, VX 777. The modification was completed late in August last year and 777 has since served as the aerodynamic test vehicle for the B.2. It is evident that the new wing takes the kinking process, which produced the Phase 2 wing of the Mk 1 aircraft, a stage further. As far as can be determined the inner wing of the B.2 is the same as that of the Mk 1, but the sweep angle outboard of the first kink has been reduced. As a result the thickness/chord ratio over the outer part of the wing has been greatly reduced, while both area and span have been increased. The inescapable conclusion is that—even had the power remained the same as before—the B.2 will be able to fly much higher than its predecessors and be able to pull appreciably higher g at all operational altitudes. The flying of VX 777 at Farnborough indicated that all the movable surfaces on the trailing edge are elevons, serving as either ailerons or elevators.

No details may yet be given of the number of Vulcans built or on order, or of the proportion of the total which will be of the new Mk 2 version. Suffice to say that the Vulcan is one of the most potent bombing aeroplanes flying anywhere in the world at this time; and the only jarring note in an otherwise magnificent picture is that the R.A.F.'s establishment for such aircraft is relatively so small that Avro cannot build the Vulcan anything like as rapidly as their capacity permits.

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Straight and Level

● Where lies Truth, if not at the bottom of her well? Leonard S. Hobbs, an engineer whom I respect very highly indeed, and who is now chairman of United Aircraft, has taken some trouble to point out that Whittle was not necessarily first in the turbojet field; he is inclined to give the palm to the Germans. Of the latter nation's gas-turbine men the first in the field was von Ohain; he had his first engine running by March 1937. The first Whittle unit, the U-1, was running the following month.

But one could argue that both were preceded by Lysholm, the famous Swedish turbine firm, who conducted extended gas-turbine trials during the late 1920s and ran a turbojet—intended for aircraft propulsion—in 1934. And, of course, there is always René Leduc.

Suppose someone takes his courage in both hands and states flatly that Mr. X was the first man to run an aircraft jet-propulsion engine; I'd be delighted to prove that it was Mr. Y.

● Everyone knows that more transport aircraft work capacity means more earning capacity. But an awful lot of nonsense is written and spoken about the relationship of greater work capacity to *economy*. I have just been treated to a comparison between the work capacity of the new jets compared with the aircraft which they will replace—presumably aimed to indicate that, *ipso facto*, the big jets will earn much greater profits.

Just because a vehicle produces more it doesn't mean that it produces it more cheaply. Nor is all that it produces necessarily sold.

● When you don't know the real designation of something, it's a good idea to identify it by a code name: hence NATO's names for the Russian aircraft of today. The same idea was used, successfully, in the Pacific in World War 2, when Japanese aircraft were given boys' names (fighters), girls' names (bombers) and so on. But the titles were never derogatory, unlike the U.S. appellations "Crate," "Fagot" and others. Perhaps cold wars make one ruder than a shooting war.

● Conversation with Canadian:—

Self: "How did you find that T.C.A. Viscount?"

Canadian: "Well, I didn't think it was all that quiet; I was sitting right by the props and I thought it was quite noisy. You know what I think—the Viscount's like the Volkswagen, everyone thinking it's terrific for no reason except that everyone else does."

Self: "How do you *start* making everyone think you're terrific?"

Canadian: "Um . . . yeah, well, I guess you just have to be that much better than anything else."

● The designers of the Vickers VC.10 and of the Bristol 200 have independently decided upon the T-tail. There are three reasons: (1) because it is the best scheme, (2) any other scheme would not be as good, and (3) because—I now realize—of the beetle influence.

The picture shows M. Charles de Rougé, a French engineer, who has been studying the aerodynamic geometry of

beetles—such as the one he is holding—with a view to improving the stability of aeroplanes. M. de Rougé is not fooling: he has been working on this project for 30 years.

● Making models for high-speed tunnels is a time-consuming job. In view of automatic control of machine tools—always just around the corner—how about punching out a set of cards or tape, or whatever it is, for the model, and getting the right shape straight off? Then you merely modify the tape to suit tunnel results, and finally insert a suitable scale-factor to make the full-size prototype. Later mods. are brought in merely by posting a corrected length of tape to wherever the big skin mills happen to be.

● Bob, an American friend of mine, recently came across a whole mass of his old cheque-stubs, and in no time lost himself in a sort of orgy of sentimentality. There was the stub for the cheque that paid for his first term at Aviation College (there are lots of those in the U.S.) . . . this one was for the perambulator for his first baby . . . and this one was for a U.S. Army Air Corps mess bill.

I had a similar experience last week. Looking for a book, I discovered one of my old "half-million" air maps—it was my own favourite, most-used, much-thumbed sheet. In no time I was living it all again. There were all the names I had forgotten . . . and "10 deg 30 min W (1942) . . . hundreds of pencilled lines . . . old signs, marginal notes, annotations galore—even a beloved coffee stain, dating from a very rough trip in an Anson. Take my advice, you pilots and navigators: never lose or destroy your old maps. Grandchildren in 1987 will be even bigger sceptics than those of today.

● Go into any technical office in the world and this sort of thing happens:—

Self: "What's that hole in the inner skin for?"

Man Who Ought To Know: "Oh, er . . . can't remember offhand, but I seem to remember it was . . . um . . . perhaps I could drop you a line on that."

The funny part is, of course, that after you've gone, the whole office have a panic-stricken search to try to find out what the hole *was* for; and nine times out of ten nobody can remember. I know one production item whose price was appreciably reduced by cutting out a pair of forged lugs, simply because nobody could remember what they were there for.

● One of the fundamental characteristics of the gas turbine is that it handles its working fluid (mostly air) at a great rate. Air rushes in at the front, fuel is squirted in at the mid-point and hot gas comes out at the back. What's left inside? Just a trace of carbon. A rough check shows that only 0.00000001 per cent of the total throughput is left behind inside the engine as residue. Not worth worrying about? On the contrary, it can have a significant effect on engine performance.

As a corollary to the above one can point out that the 0.00000001 per cent ratio is considerably upset by nuts and bolts coming in at the intake. Either they stay quietly inside the engine and multiply the ratio by a few million, or most of the blading pours out of the jet-pipe; the result is then a negative quantity.

● For the sake of readers in Italy it is worth correcting a wrong impression which a recent article in an Italian aeronautical paper may have created. This impression is that "Project Vulcan," American G.E.'s fast-firing aircraft gun (as fitted to the Lockheed F-104A), is merely a revolver cannon like our Aden, America's M-39 or the pioneer German MG-213C. In fact, as far as recent fighter weapons are concerned, Vulcan is quite a new device. It has six barrels and operates on the familiar Gatling-gun principle. Nothing new under. . .?

● When your product is not selling too well, while that of your rival is, a morale-boosting free-lunchmanship ploy is to say: "Not only is there a market for both types, my dear chap, but there is even room for a third."

ROGER BACON

Aircraft Electrical Systems

A CRITICAL APPRAISAL - - - PART 2

By A CHARTERED ELECTRICAL ENGINEER

Now in production by the English Electric aircraft equipment division in Bradford, the Sundstrand hydraulic constant-speed drive is already well proven in American military service. The photograph shows the standard British model, rated at 40kVA.

IF the papers and discussions at the May 1956 I.E.E. Convention on Electrical Equipment* are anything to go by—and if the speakers adhere to the views then expressed—it must be admitted that the position in regard to aircraft electrical systems is somewhat confusing. It would seem (once again to an electrical engineer outside the aircraft industry) that the logical line of development was towards a standardized constant-frequency A.C. system for that class of aircraft which includes Vanguards, Britannias and Comets. Perhaps the A.C. system, having been proved in a British Service aircraft or two, could find its way into a large civil transport and then by a process of development into a medium transport, so that eventually most electrical requirements could be met from ranges of standardized A.C. components in various sizes. The few odd D.C. components that might still be essential could be supplied from small rectifier units. It sounds far too simple, but wouldn't it be handy for everyone concerned!

Actually that is what has been happening in the United States since 1949, particularly with regard to A.C. systems making use of the Sundstrand drive. This unit was proved in such aircraft as the B-36 and is now being adopted for the two big civil transports mentioned in Pt. 1 of this article. Having found that the constant-frequency system really works the Americans are going ahead. As related in detail in *Flight* for November 15 last, late-model B-52G aircraft have Sundstrands in place of turbo-alternators energised by bleed air. The American General Electric Company have also developed a constant-speed drive in the form of a hydraulic ball-piston unit. It is incorporated in complete aircraft generating systems placed on the market in 1956. G.E. also have a new constant-frequency power package using the G.E. drive and a statically excited alternator; they claim: "smaller and lighter than conventional drive and generator combinations of the same rating, the 20kVA, 8,000-r.p.m. drive delivers a full 32 h.p. over an input speed range of 4,300 to 7,500 r.p.m." The power package is used on the Grumman F11F Tiger.

In this country the English Electric Company have been responsible for the development of an A.C. constant-frequency system with alternators driven through Sundstrand units, but it does not seem to be at all popular with British civil aircraft constructors. Neither have they taken any interest in bleed-air turbo-alternators. Maybe the British constructors have their own good reasons for not wanting constant-speed drives and A.C. systems; possibly they do not like taking a chance with something new, preferring to stick to equipment which now after several years of service is reasonably free of "bugs" and on the whole pretty satisfactory. Apart from the drive units themselves the A.C. system does, of course, involve new and relatively untried components. It may well be that aircraft constructors don't want to start from scratch with these components. Perhaps they are right to be cautious, having regard to the possible troubles they might be letting themselves in for; but since it looks as though the constant-frequency system really does have advantages, which become more pronounced with increasing power demand, then it is a pity that the system has yet to go into a British civil aircraft. It seems that the English Electric constant-frequency system is being put through its paces in a V-bomber, but unfortunately no information will be forthcoming about its performance in service.

*Extracts were quoted in Part 1 of this article, last week.

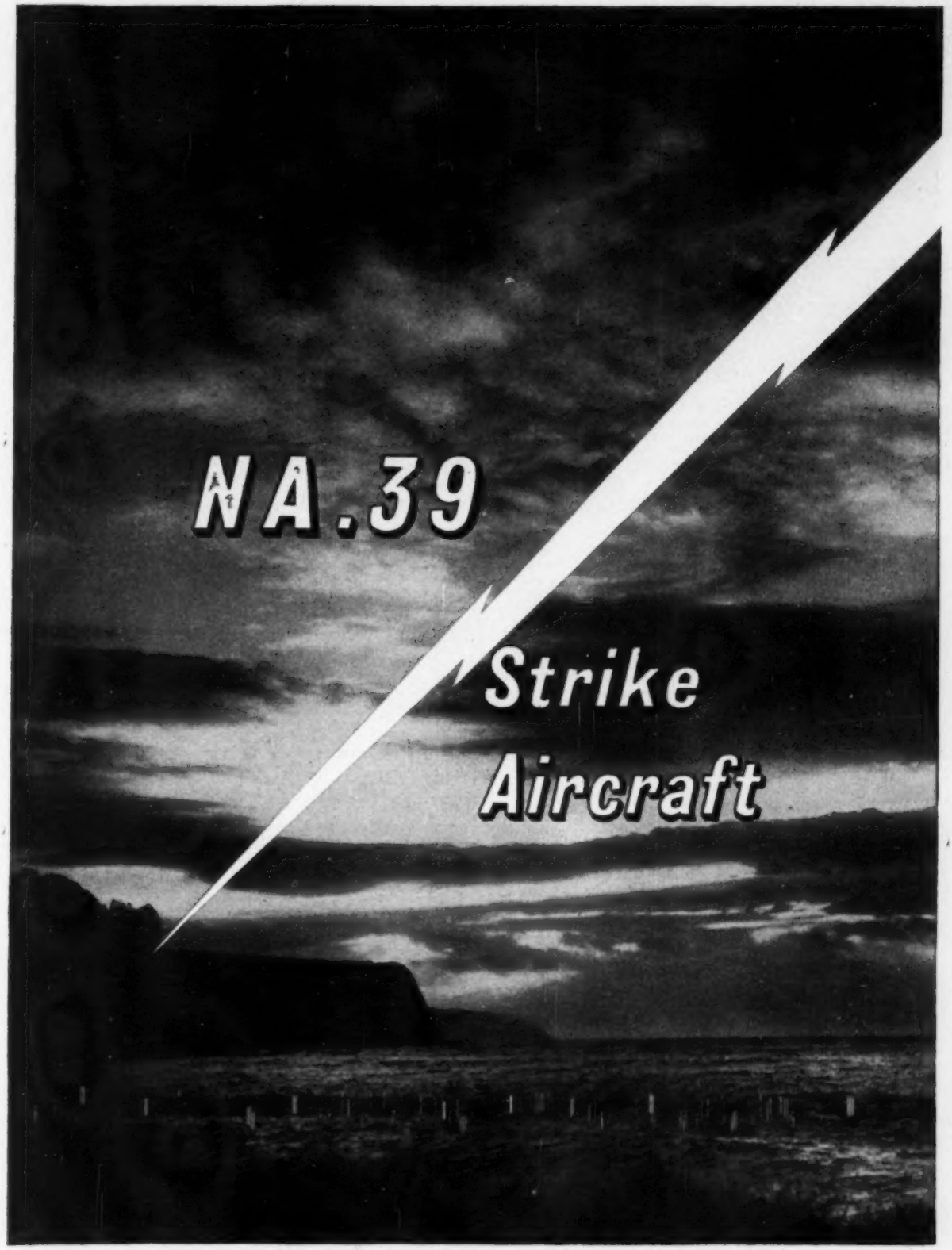
Miniature A.C. induction motors are widely used in aircraft, taking supplies from variable-frequency alternators or inverters. The units illustrated are by B.T.H.

An interesting alternative to the Sundstrand-drive (produced under licence by the English Electric Company in Great Britain) is the hydraulic constant-speed drive and alternator developed by H. M. Hobson, Ltd., in conjunction with Integral, Ltd., and the British Thomson-Houston Co., Ltd. Described briefly in *Flight* for November 15, this unit offers the advantage that after one engine has been started by some sort of conventional starting unit, each of the other alternators can be operated in turn as an A.C. motor running at synchronous speed, starting torque being applied to the engine through the C.S.D., its ratio being controlled automatically by the starting current input to meet the starting requirement of the engine. Starting time is relatively long, but admissible for transport and bomber aircraft.

Making one machine do the work of two always pleases the electrical engineer, apart from saving weight; which brings to mind that the D.C. starter-generator is another reversible set-up that on the face of it looks like an attractive engineering proposition. But although so-called starter-generators have been developed, the arrangement does not appear to have got into any aircraft. It seems that at one time the Vanguard was to have starter-generators but plans were changed and a rectified A.C. system decided upon. One of the difficulties seems to be handling the starting current without the possibility of brush deterioration likely to affect serviceability of the machine as a generator.

One is inclined to wonder what aircraft constructors really think are the snags about the constant-frequency A.C. system. Is it that the constant-speed units are considered unsatisfactory? Generators have been driven at variable speed from accessory gearboxes for so long now that perhaps British aircraft designers don't fancy any other sort of drive—apart from any alleged weight penalties. If designers are shying away from constant-frequency systems because they think, or know, that constant-speed drive units are not likely to be as satisfactory in practice as some people claim, then perhaps they might be interested in the range of *variable-speed* constant-frequency alternators under development by Rotax, Ltd.

Examples of these alternators were shown at Farnborough for the first time last year and a publicity release implied that a range of these machines was more or less available. It seems, however, that at the beginning of September these alternators were still under development. Rotax designers were being somewhat cautious about making claims—and rightly so, for claims have been made by other people for things that didn't work out in practice. But this Rotax alternator seems to be on the right lines and with the obvious advantage that it can be driven from an accessory gearbox. A provisional specification of the performance of a typical 60kVA alternator was available at Farnborough. Over the variable speed range of 4,500-13,500 r.p.m. a supply is given at 208 volts ±1.5 per cent at a frequency of 400 c/s ±0.5 per cent. Operating temperature range is −40 deg C to +50 deg C and it is stated that the maximum altitude is dependent upon cooling, there being both



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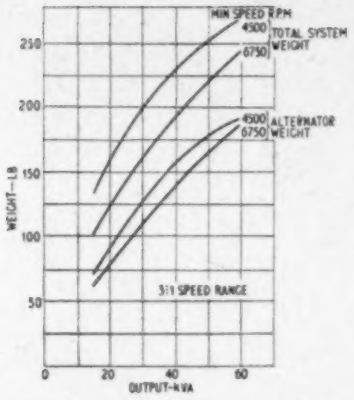
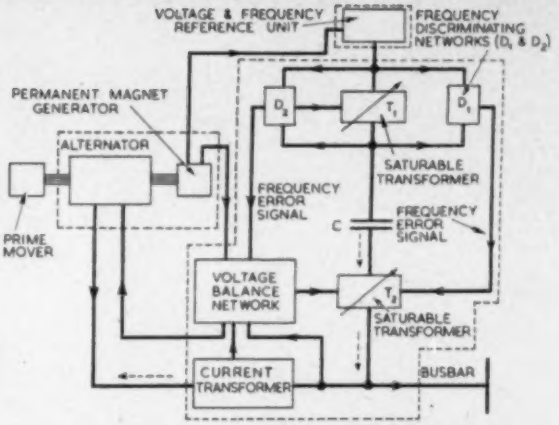


Preliminary information upon their range of variable-speed constant-frequency alternators was issued by Rotax last year. On the left are company curves for weight/output characteristics.

(Right) Diagram showing components of the Rotax variable-speed constant-frequency system.



AIRCRAFT ELECTRICAL SYSTEMS . . .

air-cooled and oil-cooled versions of the alternator. The air-cooled machine is 25.8in long, 13.5in wide and 11in high, and weighs 173 lb; the oil-cooled machine is 24in long, has the same width and height, and weighs 178 lb including the weight of the filter and oil pump. The control gear that is required to enable the alternator to give a constant-frequency output with a variable-speed drive weighs 78 lb.

These new Rotax alternators should prove most useful in the development of constant-frequency A.C. systems, assuming that no snags are encountered in practice. There would appear to be a particular advantage in that the alternator, being an asynchronous induction type, does not have any brushes and sliprings, which should make it superior to any other conventional type of alternator for operation at high altitudes. Moreover, since the entire voltage and frequency-control unit has no moving parts there should be an increased safety factor and low maintenance costs. English Electric, one learns, are developing a brushless alternator, together with a voltage regulator with a minimum of moving parts.

British manufacturers appear to be doing their best to provide the basic components for aircraft constant-frequency electrical systems. Another contribution is being made by Rotol, Ltd., Lucas-Rotax and others through their development of a range of bleed-air turbo-alternators, speed controlled by means of an air-valve operated by a servomechanism responding to a frequency-sensitive unit. There are also mechanical drives, such as the Hayes transmission developed by Tiltman Langley, Ltd. Such units should have possibilities for electrical designers concerned with developing a constant-frequency system. But judging from *Flight's* second review of the world's commercial aircraft (November 1) the British designers of civil aircraft electrical installations seem to have no interest in the constant-frequency system, despite the fact that the Americans appear to have definitely decided in favour of it for their biggest aircraft. It could be that the Americans are wrong—or that the British are timid! It was about fifteen years ago that constant-frequency systems were first being given serious attention, and tried out by using auxiliary power units, and the advantages were being emphasized by various authorities. There were, however, difficulties in incorporating these A.P.U.s, and a fire in the unit developed for the Short Shetland flying-boat destroyed the whole aircraft. According to Randolph Matson in his book *Aircraft Electrical Engineering* (McGraw Hill, 1943) the first experimental DC-4 was equipped with an 800 c/s single-phase A.C. system derived from auxiliary generating plants, but the system was not adopted, mainly for reasons of weight. Matson noted that 400 c/s three-phase alternating current had been adopted by the A.A.F. for large aeroplanes, but the basis of the system was again auxiliary generating sets, with a rectified D.C. supply, and in one case the system included a 12-volt battery charged from rectifiers. It is interesting to note that there have been recent developments in auxiliary generating units, notably the Artouste 475 h.p. airborne unit of Blackburn and General Aircraft, which was shown at Farnborough equipped with a 43kVA Plessey alternator.

So it seems that there is quite a lot of A.C. equipment around waiting to be used by a civil aircraft electrical designer. The designers may have very good reasons for not wanting A.C. systems, but perhaps they have not made them clear enough to avoid an accusation of prejudice against such equipment. Maybe the frequency-wild A.C. system with rectifiers has all the advantages (despite the rotating inverters) since it seems to be particularly popular. Moreover, it may be capable of even further development, especially by incorporating silicon rectifier units in place of existing selenium rectifier units. It should be interesting to watch developments to discover whether in due course everyone concerned can really get together to agree upon something like a standardized electrical system.

PLESSEY DIRECTORSHIPS

APPOINTED to the Board of the Plessey Co., Ltd., as executive directors are Mr. W. Dalziel, production manager of the electronic and equipment group and Mr. H. Fox Wright, contracts manager of the company.

Mr. Dalziel, who is 41, joined Plessey at Ilford in 1938 as a progress chaser. Since then he has specialized in all aspects of divisional management within the progress planning department.

Mr. Fox Wright, who joined the company in 1937, received his aeronautical training at the de Havilland Technical School, and before joining Breeze Corporation (a Plessey subsidiary) as sales manager, he held a commercial post with de Havilland. In 1946 he was appointed contracts manager of the Plessey Co.

Mr. Fox Wright. *Mr. Dalziel.*

NEW CRANFIELD PROFESSOR

THE Governing Body of the College of Aeronautics, Cranfield, announces the appointment of Mr. Austin Geoffrey Smith, A.R.C.S., B.Sc., D.I.C., to the Chair of Aircraft Propulsion.

Mr. Smith graduated with first-class honours at the Royal College of Science, then studied aeronautics at City and Guilds College. During the war he worked at Power Jets, Ltd., on aircraft engine research and development, and was later at the National Gas Turbine Establishment, where he was a principal scientific officer. Since 1952 he has held the post of Reader in Applied Thermodynamics (with special reference to gas turbines) at Imperial College, London, where he is in charge of the post-graduate course in gas-turbine technology. He will take up his appointment at the end of the present academic year.

"FLIGHT" PHOTOGRAPHS

MANY of the photographs reproduced in *Flight*, i.e., those taken by our own photographic staff (as indicated on publication) are subsequently available in the form of high-quality prints. Prices are as follows (dimensions given in inches): $5\frac{1}{2} \times 3\frac{1}{2}$, 1s 4d (glossy or semi-matt, unmounted), or 2s (toned sepia, unmounted); 6×4, 2s 6d or 4s; 8×6, 3s 6d or 5s 6d; 10×8, 5s or 7s 10d; 12×10, 6s or 9s 8d; 15×12, 9s 6d or 13s. Larger prints can be supplied in special sizes to order (semi-matt finish only) from 20×16 at 13s 0d up to 40×60 at 6 gns.

Also available are a postcard series, totalling over 200, depicting both historic and modern aircraft of the R.F.C., R.N.A.S., R.A.F. and Fleet Air Arm. Complete lists of the series are obtainable on application. Prices are 8d each card, or $7\frac{1}{2}$d each for quantities of a dozen or more.

On postcards, also at the same prices, are reproductions of general-arrangement drawings of some 20 British aircraft that have appeared in our "Aircraft Intelligence" pages.

Left, ultrasonic inspection of a large forged titanium slab, which at this stage is probably worth something in the region of £2,000. Right, a selection of titanium products, including a forged turbine disc, drawn tube, sheet, wire, and precision die forgings.

APPLIED METALLURGICAL RESEARCH

RESEARCH is a long-term investment which does not always pay immediate dividends, but without it no engineering firm can hope to keep abreast of industrial developments. At few establishments can this be more fully appreciated than that of William Jessop and Sons, Ltd., of Sheffield, six per cent of whose staff are employed on evaluating and developing new alloys and means of producing them.

On an average, one new alloy a year is marketed by Jessops, though many more are the subject of constant experiment. Each new alloy involves about five hundred melts; and each melt involves exhaustive tests of analysis, temperature, creep and fatigue resistance and other properties. Viewed in this perspective, the size of the research department does not seem disproportionate.

Methods used by the company in the production of titanium were described in our issue of August 16 last year and it is not proposed to enlarge on the process here; but certain specific difficulties, and the efforts to solve them, are of interest. By far the most pressing problem, and one that contributes considerably to the high cost of titanium, is that of utilizing scrap. The reason for this is the nature of the melting process, in which crushed titanium sponge forms one of the electrodes for an arc struck in an evacuated chamber. To make an electrode from swarf and other scrap purely by crushing (no binding agent is used) is by no means easy; and until some way of doing so, or some other method of melting and homogenizing titanium alloy is evolved, scrap can be used only in very small quantities.

The purity of the titanium sponges received has an appreciable effect on the end product, and tests are made by melting a sample in a small vacuum furnace using a tungsten electrode. The resulting "button" of titanium is sectioned and hardness-tested, greater hardness indicating a larger proportion of impurities. Even very small quantities of impurities have a considerable effect on the characteristics of titanium, and methods for their detection are extremely precise.

A vacuum of about half a micron of mercury is achieved during the melting process, and oxygen content can be brought down to about five parts per million. As is well known, this technique applies to materials other than titanium, and Jessops use a small vacuum induction furnace for trial melts and casts of many new alloys—particularly of high-tensile materials and alloys containing aluminium, which oxydises when melted with other materials in ordinary atmosphere. The alloying materials are mixed, melted and poured into the mould by remote control.

Jessops have over 200 creep machines on which representative samples are tested for up to 70,000 hr; exhaustive data of this sort are a strong selling point with new alloys and the same thoroughness is applied to fatigue testing and analysis. For the latter much use is made of X-ray metallography which in many respects gives more accurate and detailed information than does chemical analysis.

It is the painstaking and systematic use of techniques such as these, and the logical and prompt application of the knowledge gained, which demonstrate the seriousness with which Jessops take this costly, often tedious, but rewarding side of their work.

THE INDUSTRY IN BRIEF

Changes on the Board of the Fulmer Research Institute follow the resignation of the chairman, Mr. Spence Sanders, on his retirement from the Board of Almin, Ltd. His place as chairman of the Institute has been taken by Mr. W. R. Merton, and Mr. J. G. Graham has been appointed a director.

* * *

Claimed to be the most modern transistor plant in the world, the new factory being built for Semiconductors, Ltd., at Swindon, Wilts, is almost complete. The building is clad entirely with aluminium and is air-conditioned to exclude dust. It has no windows, and all internal surfaces are coated with P.V.C.

* * *

Appointment of Mr. Guest Hake as quality control and inspection manager is announced by Avro Aircraft, Ltd. Mr. Hake, who is at present Avro Arrow project designer, will succeed Mr. Joseph Fairbairn on March 1, at the same time becoming a member of the Avro management committee. Mr. Fairbairn, who retires on July 31, has been with the company since January 1953, at first as chief inspector and for the last two years as quality control and inspection manager.

* * *

The Ultra Electric Co., Ltd., have completed reorganization of their special products division at Western Avenue, Acton, London, W.3. Under the managing directorship of Mr. A. V. Edwards, who is also a director of the company, the division has three departments: commercial (including sales), engineering, and production; they are headed respectively by Mr. A. M. Pollock, commercial manager; Mr. W. H. Medcalf, A.M.I.E.E., A.M.I.Mech.E., chief engineer; and Mr. R. M. W. Grant, M.I.E.E., M.I.Mech.E., factory manager (who is also in charge of all production activities). Ultra's special products division manufactures a variety of radar equipment, electronic aids and electric controls and also makes the Sarah rescue beacon.

* * *

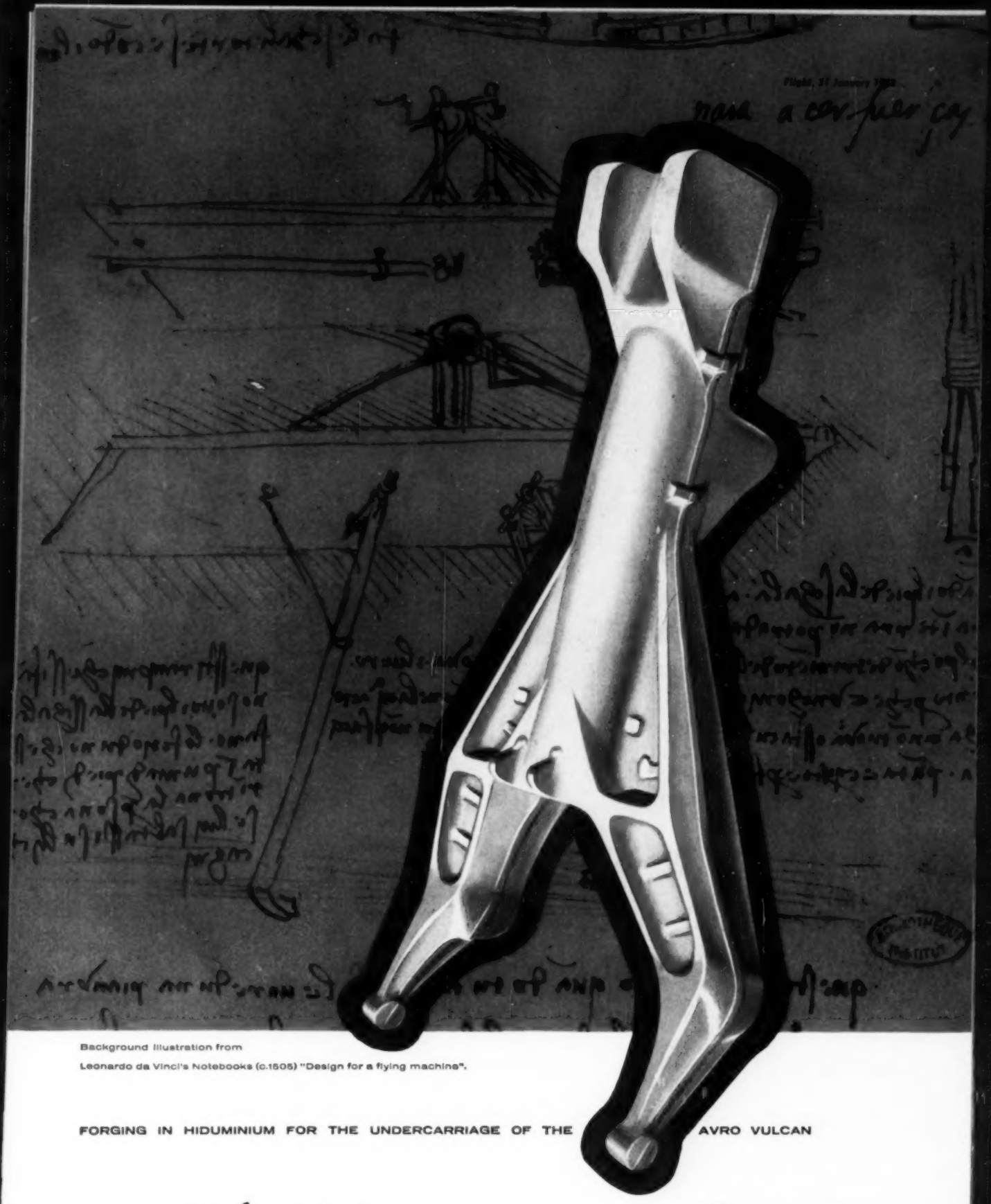
Mr. H. R. Whyte, A.M.I.E.E., has been appointed technical director of Hellermann, Ltd., and Mr. C. E. D. Catley joins the Board as works director. Mr. S. E. Downer becomes manager of the cable accessories division, Mr. P. Steer manager of the plastics extrusions division, and Mr. P. Bowthorpe assistant sales manager.

* * *

At the annual dinner of Precision Rubbers, Ltd., held in Leicester on January 11, the managing director, Mr. T. L. Garner, said he was not apprehensive of cuts in the aircraft industry, though this was one of the company's main outlets and greater effort would now be necessary if they were to obtain their share of future business. The company intended further to increase their interest in aviation, and in this connection they had developed a wide range of silicone-rubber seals with improved characteristics.

* * *

Demonstrated in London last week was a new product of Goodyear Pumps, Ltd., Camborne, Cornwall, in the form of a continuous self-priming, self-lubricating pump of original design. The principle of the Archimedes screw is employed, but the addition of a radially slotted disc engaging with the screw, in conjunction with bonded-rubber sealing devices, ensures positive displacement of fluid. Liquids of widely differing viscosity can be handled, and many industrial applications are foreseen.



Background illustration from
Leonardo da Vinci's Notebooks (c.1505) "Design for a flying machine".

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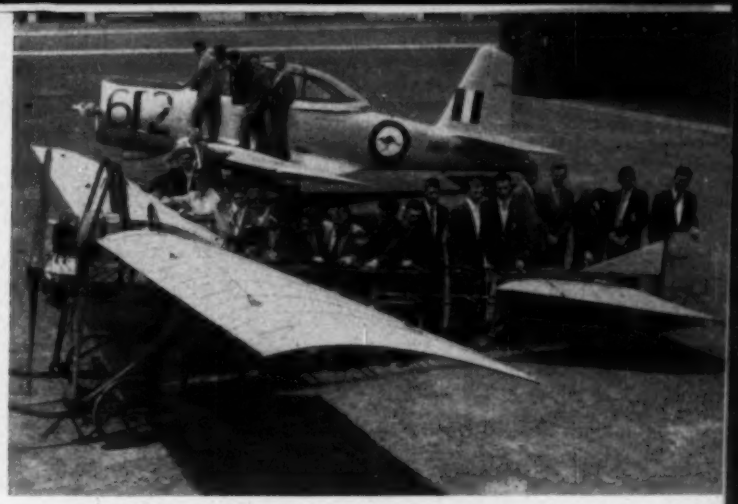
SERVICE AVIATION

Royal Air Forces and Naval Flying News



New cadets at the R.A.A.F. College, Point Cook, take a look at a Deperdussin which came to the aviation school there in 1913. With it is a Winjeel.

Bomber Operations Director

SUCCESSOR to W/C. Guy Gibson in 1943 as C.O. of No. 106 Sqn. and in control later of the attack on the V-weapon base at Peenemunde as Master Bomber of the P.F.F., G/C. J. H. Searby has been appointed Director of Operations (Bomber and Reconnaissance) at Air Ministry as acting air commodore.

A. Cdre. Searby was awarded an immediate D.S.O. for leading the Peenemunde attack, when he was C.O. of No. 83 Sqn. He had earlier that year won the D.F.C. when with No. 106 Sqn. His post-war appointments have included command of R.A.F. Hemswell (1953-54) and duty with the British Joint Services Mission in Washington, D.C., on the bomber operational development side. In January last year he became G/C. Operations at H.Q., Bomber Command.

Senior Appointments

APPOINTED A.O.C. the R.A.F. Record Office, Gloucester, from January 22, A. Cdre. A. L. Derry has been succeeded as Director of Personnel (Ground) at Air Ministry by G/C. C. V. Mears, who was formerly S.O.A. at H.Q. No. 90 (Signals) Group and becomes acting air commodore in his new post.

A. Cdre. Derry was permanently commissioned in the Accounts Branch in 1925 and his previous appointments have included those of a Deputy Director of Manning at Air Ministry and Command Accountant, F.E.A.F. He was made C.B.E. in the 1955 New Year Honours.

A. Cdre. Mears was in 1949 Vice-President of the R.A.F. Selection Board and in 1951 became a Deputy Director of Intelligence at Air Ministry. He was twice mentioned in despatches during the war, and again in 1946; and was made C.B.E. in 1954 and last June appointed an aide-de-camp to the Queen.

R.A.F. Tangmere

WITHIN the next twelve months R.A.F. Tangmere, whose wartime squadrons destroyed over 500 enemy aircraft between July 1940 and April 1941, will cease to be an operational airfield in Fighter Command. No. 1 Sqn., equipped with Hunter 5s, is to be moved elsewhere.

No. 820 Sqn. Commissioned

AN indication of the trend towards the use of helicopters rather than fixed-wing aircraft for Naval anti-submarine duties was given by the commissioning at R.N.A.S. Eglinton, N.I., on January 21 of No. 820 Sqn.—which used to be equipped with Gannet AS.1s and has now been re-formed to operate Whirlwinds.

At the commissioning ceremony the C.O. of the station, Capt. T. G. C. Jamieson, told members of the squadron that there was always a controversy nowadays about fixed-wing aircraft and helicopters, and No. 820's arrival at Eglinton had "brought it on rather more intensely." He added: "Whilst our opponents—though I don't say we will have opponents—have hordes of conventional relatively slow submarines, there is obviously a case for both fixed-wings and helicopters. But with the atomic-type submarine—unless there is a great scientific breakthrough, and we can never say there won't be—the helicopter will have it all the way."

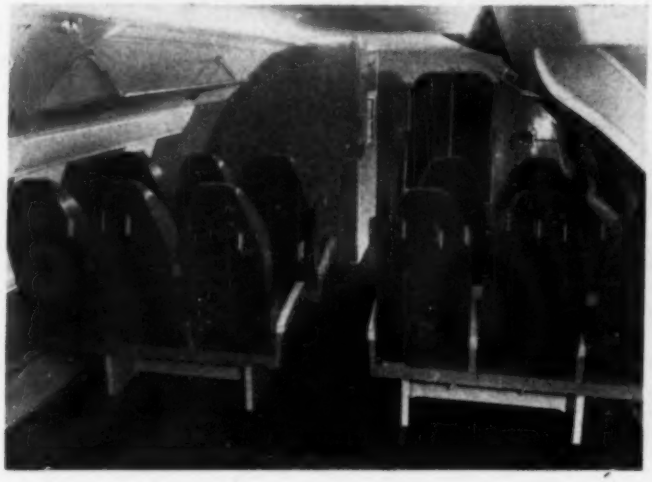
Recent Postings

AMONG R.A.F. appointments recently announced by Air Ministry are the following:—

W/C.s A. Boonham to H.Q., No. 90 Group, for technical staff duties; C. H. C. Down to H.Q., No. 19 Group, Coastal Command, for technical duties; M. A. Ensor to the Maritime O.T.U., Kinloss, to instruct; C. G. St. D. Jeffries to R.A.F. Lyneham, for flying duties; F. C. Lowe to Air Ministry, for duty in the Department of the Chief of the Air Staff; J. W. McKelvey to Air Ministry, for duty in the Department of the Chief of the Air Staff; D. L. Prichard to H.Q., Transport Command, for administrative staff duties; D. S. Sanderson to Air Ministry, for duty in the Department of the Air Member for Supply and Organization; T. Wharton to R.A.F. Changi (Singapore), for technical duties.

S/L.s F. E. Barnes to the Ministry of Supply (exchange post in the U.S.A., with the acting rank of wing commander); B. Brooke to the R.A.F. Technical College, Debden, to instruct

These views of the fuselage mock-up prepared by Short Bros. for the Britannia 253 which is to go into service with R.A.F. Transport Command show the furnishings as they will appear in the production aircraft, with the new Short-designed seats (which will be rearward facing and were described in "Flight" last week, page 108) represented by wooden models. Plastic ducts above and below the windows conceal attachment points for stretcher and iron lung fittings, and the air quarter-master's table in the foreground (right-hand picture) is illuminated by an Anglepoise lamp mounted on the wall. Below, the galley can be seen (rear, left).



A 12ft-long model of a helicopter carrier, equipped with the Westland Wessex, being described by R.M. Capt. A. J. Torrance to three R.E. students on a course at the R.M. Joint Services Amphibious Warfare Centre at Poole in Dorset. The model, based on a converted light fleet carrier, is used to teach the theory of mass helicopter landings combined with amphibious operations. On the right can be seen a new prototype survival suit, made of p.v.c., being tested at Portsmouth on January 20 alongside a standard Naval airman's immersion suit.

SERVICE AVIATION . . .

(with the acting rank of wing commander); G. E. Jones to Air Ministry, for duty in the Department of the Chief of the Air Staff (with the acting rank of wing commander); G. A. Sentance to R.A.F. St. Athan, for administrative duties (with the acting rank of wing commander); J. W. S. Smith to R.A.F. Kirkbride, to command No. 12 M.U. (with the acting rank of wing commander).

N.I. Recruiting Centre

NO. 59 Recruiting Centre at Belfast—the only R.A.F. recruiting centre in Northern Ireland—was to enter new premises in Victoria Street last Monday. The opening was to be carried out by the Lord Mayor, Ald. W. C. McKee, and the Senior R.A.F. Officer, Northern Ireland, G/C. R. H. C. Burwell, was to attend the ceremony. The premises replace ones in Clifton Street which had been in use for 16 years.

Shephard Essay

A NEW subject has been chosen for the 1958 Gordon Shephard Memorial Prize Essay competition. Instead of discussing the relative merits of naval carrier task-forces and land-based aircraft (as announced on November 22), competitors have been asked to write on the following:—

"It is the declared intention of Her Majesty's Government to cease calling up men for National Service by the end of 1960 and, by January 1, 1963, to achieve an all-regular Air Force. Discuss practical measures which would enable us to achieve this aim."

The Gordon Shephard essay competition originated in 1918 when the late Sir Horatio Hale Shephard founded a trust to provide cash prizes for an annual R.A.F. essay competition in memory of his son, the late Brig-Gen. G. S. Shephard, D.S.O., M.C., R.A.F.

Lt-Cdr. Kelly Memorial

A PLAQUE in memory of the late Lt-Cdr. D. P. W. Kelly, the noted F.A.A. aerobatic pilot who was killed in a flying accident at R.N.A.S. Ford on August 26 last year, is to be placed in the chapel of the Britannia R.N. College at Dartmouth. Lt-Cdr. Kelly entered the College in 1940 as a cadet and in 1956 served there as divisional officer of the St. Vincent Division.

Friends in aviation circles who may wish to contribute to this memorial are asked to send donations to the Captain, Britannia Royal Naval College, Dartmouth, Devon. Cheques should be crossed "Lt-Cdr. Kelly Memorial Fund." Any surplus money remaining after the purchase of the plaque will be used to establish a prize to be awarded annually to the most promising cadet passing through the flying course at R.N.A.S. Brawdy each year during Phase II training at Dartmouth.

Cyprus Sycamores

SOME details of the remarkable performances achieved by R.A.F. Sycamores in Cyprus on anti-terrorist operations have been given by Bristol Aircraft, Ltd., following the visit to their Weston division of F/L. P. Fahy who until last autumn commanded No. 284 Sqn. at Nicosia.

When he took over the squadron in May 1955 it had only two Sycamores; but by December the following year this total was 13 and the helicopters were being used to land troops on otherwise almost inaccessible mountain points over 4,000ft a.s.l.

The element of surprise provided by the Sycamores (each of which can carry three soldiers) has proved a decisive factor in the anti-terrorist campaign, and the extent to which they were employed is indicated by the fact that in the year ending last August No. 284 Sqn. flew a total of 4,160 hr. Its aircraft strength varied between nine and 13, one of these machines being on 24-hr standby for casualty evacuation duties and another at daylight readiness for air/sea rescue calls.

IN BRIEF

F/O. P. Brighton, who recently completed his basic flying training with No. 6 F.T.S. at R.A.F. Tern Hill, won five out of the six trophies awarded to his course and in addition equalled the previous best marks awarded for the examinations by the Central Examining Board.

* * * * *

With a few results still to come in, the Royal Air Forces Association's 1957 Wings Day collection stood last week at a total of £67,000.

* * * * *

In the 1957 Inter-Command M.T. competition R.A.F. Feltwell, Norfolk (Flying Training Command), was judged the most efficient station in the senior division and R.A.F. Amport, Hants (Maintenance Command), the most efficient in the "junior" section.

* * * * *

A silver chalice and paten presented to the R.A.F. Church of St. Clement Dane's by the No. 38 Group Old Comrades Association will be dedicated in the crypt chapel of the church by the R.A.F. Chaplain-in-Chief, Canon A. S. Giles, at 5 p.m. on March 8. This is immediately prior to the Association's annual dinner, and it is hoped that many members will also be able to attend the simple service of dedication.

A.V-M. P. D. Cracroft, Senior R.A.F. Officer, Scotland, A.O.C. No. 18 Group and A.O.C. Cadets, inspecting A.T.C. cadets at R.A.F. Turnhouse when he opened No. 661 Gliding School there on January 18. With him is the Lord Provost of Edinburgh, Cllr. Ian A. Johnson-Gilbert, who in the First World War served with the R.F.C.

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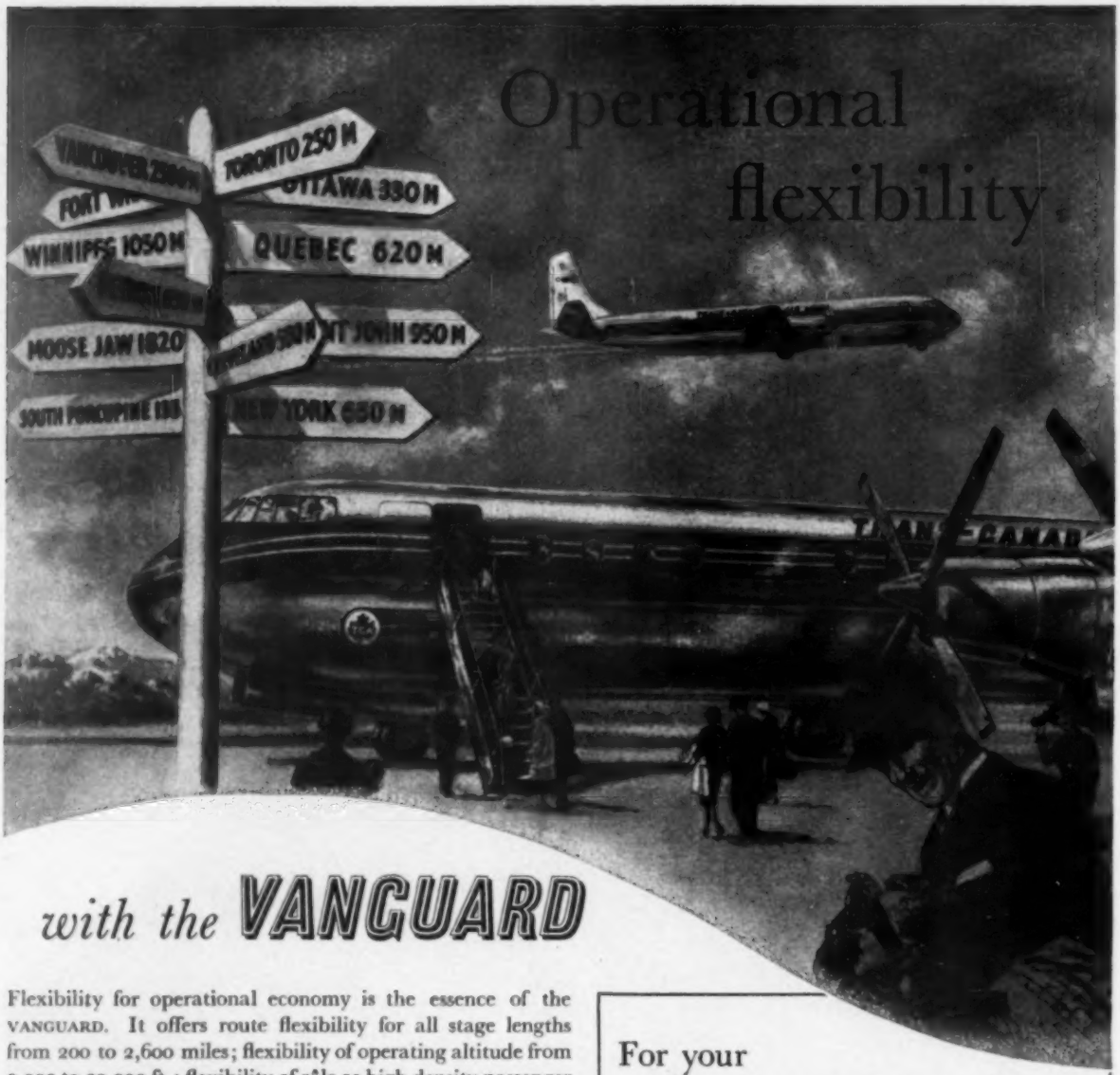

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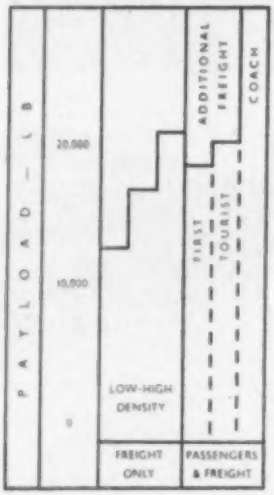
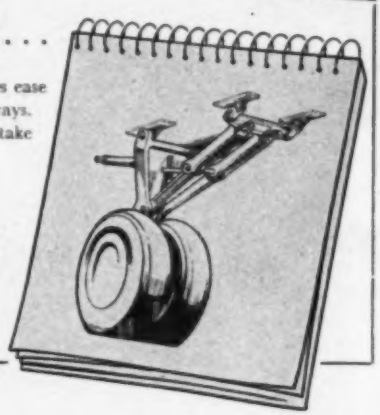


For your notebook . . .

Low-pressure tyres ease the stress on runways. Those which can take the VISCOUNT can also take the VANGUARD. Take-off and landing distances are modest.



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CIVIL AVIATION

CAPITAL BUY 880s . . .

MOST people's first reaction to Capital Airlines' order for 15 Convair 880s, to be delivered from September 1960 at a cost of $60 million, must have been that the airline has taken leave of its senses. The order is so incomprehensible that it cannot be judged by normal air transport business standards.

An order of this size and timing by Capital is not a logical sequel to that airline's actions during the past eight months, as recounted in *Flight* of January 10. The airline's financial troubles became publicly known last May, when the company "deferred" its repeat-order for 15 Viscounts and its order for four Comet 4s and ten Comet 4As. Then in the summer it took the lead in the U.S. industry's subsequent campaign for higher fares—a campaign which has now developed into a propaganda battle with no holds barred, and with the moral support of the American banks. July brought the surprise appointment of Maj-Gen. David H. Baker, a U.S.A.F. financial and procurement expert, as president in place of Mr. J. H. Carmichael, who was elevated to the chairmanship. But the big shock came in November, when Capital applied to the C.A.B. for a $12.2 million subsidy to be spread over the next two years. This putting-back of the clock jolted the pride of the U.S. trunk-line industry, which has been virtually free of subsidy for five years. At the same time Capital forecast depressing losses, amounting to as much as $10 million by 1960.

The next event, earlier this month, was the resignation of Mr. James W. Austin, the company's vice-president traffic and sales, who was the driving force behind the successful "merchandising" of the Viscount. (He became president of Northeast.) Finally, within the last few days, Capital have successfully negotiated with Vickers and Rolls-Royce deferment of their $1m per month Viscount payments for January, February and March.

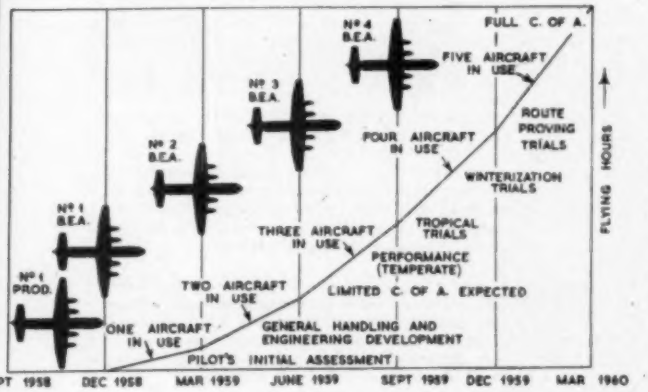
This is the background to Capital's order for 15 Convair 880s. What can be the explanation for such an astonishing *non sequitur*?

The Convair 880, which was launched on the strength of T.W.A.'s order (i.e., Mr. Hughes' order), is not selling well. Delta ordered ten at the same time as T.W.A. ordered 30 in June 1956; but during the 18 subsequent months, Convair have sold only eight more 880s—four to an as yet non-existent Argentine airline, Transcontinental, and four to R.E.A.L. of Brazil. This thin order-book (by U.S. standards) must be causing concern at Convair: only a few days ago the firm issued to the world's Press a statement of the extent to which the firm is technically and financially committed to the 880 project. Some $50 million have now been "committed or expended" on 880 development.

Certainly a new order by a major airline would give a much-needed boost to 880 sales. Capital were an obvious target for Convair, because the airline has always been favourably disposed towards jets to supplement its Viscounts, and to open up longer routes as a means of balancing the difficult short-range economics of the present network. There is no doubt that the Comets were "deferred" (they are now apparently cancelled) with reluctance.

But Capital are in no position to attract share or debt capital to the tune of $60m for an 880 order at this time. So Convair have apparently decided to finance Capital's purchase of 15 Convair 880s themselves, just as Vickers and Rolls-Royce financed Capital's 60 Viscounts.

The precise terms of this surprising deal are not available as *Flight* goes to press, but an interesting aspect is that Convair have undertaken to fulfil Capital's remaining obligations to Vickers and Rolls-Royce, apparently amounting to £17,325,000. This sum is included in the total credit expenditure capital and is said to be equivalent to £38,754,000.



. . . AND FINNAIR CARAVELLES

WITH its homeland sandwiched between Scandinavia and Russia, Finnair is obliged to prevent Aeroflot and S.A.S. from drawing too far ahead in the procurement race. Aeroflot could soon be operating Tu-104s to Finland, and S.A.S. will be receiving Caravelles next summer. B.E.A.'s Comets should be seeing service by the winter of 1959-60, very likely on the longer routes such as London - Helsinki. Unless Finnair were offering competitive equipment by 1960 their position would be in jeopardy.

The Finnish company have now announced their intention of taking delivery of three Caravelles from Sud Aviation in time for 1960's summer traffic (the six S.A.S. Caravelles are being delivered in mid-1959). An option has also been taken on a further three.

Finnair enjoy a well-founded reputation for basing policy on sound economic judgment. Assuming that purchase of new aircraft is forced on Finnair by competitive forces beyond their own control, then there are sound economic reasons for choosing the Caravelle. Their peripheral situation in Europe permits Finnair to derive greater advantage from the speed of the short-haul jet than can the airline's centrally situated neighbours. Among the available turbojets, Sud Aviation were able to offer a substantially lower purchase price and more attractive operating costs than de Havilland, Boeing or Convair.

Also on Europe's periphery are Air Algerie, Tunis-Air and Royal Air Maroc, three airlines being referred to as likely customers for the Caravelle.

AIRWORK'S INTEREST IN AIR CHARTER

ANOTHER factor behind the demise of the Accountant (see page 131) appears to be a shortage of capital on the part of Aviation Traders. This has not only prevented the company from developing its own production facilities for the Accountant, but has also restricted the sister-company, Air Charter, Ltd., in the air transport field.

Air Charter, using a fleet of three DC-4s, six Avro Tudor Super-Traders and nine Bristol 170s, is based at Southend and Stansted, its principal operation being the Channel Air Bridge linking Southend to Calais, Ostend and Rotterdam. This cross-Channel ferry service was inaugurated in 1955, and in 1956 diverted a considerable volume of traffic from ferry services already being flown by Silver City. Last year saw sharp competition both from Silver City and from the railway cross-Channel car ferries. This year will see further fare-cutting on the part of Silver City. To meet this competition, and to cater for the growing volume of traffic, would require an influx of fresh capital from outside sources.

Negotiations have been continuing between Airwork and Air Charter since last summer (well before Lord Ogmore's speech in the House of Lords stating the Government's desire to see a rationalization of the independent British airlines), and culminated last week with the announcement that Airwork had "acquired a substantial interest in the air transport and engineering group of companies headed by F. A. Laker."

THE COMMONS DEBATE CIVIL AVIATION

NOTEWORTHY points from last Monday's Commons debate on the B.E.A. and B.O.A.C. accounts—which we intend to summarize at greater length next week—were as follows.

The Minister of Transport, Mr. Harold Watkinson, said: "I should not lead the House to believe that B.O.A.C. are going to have a good financial year [to March 31, 1958], because they are not." The Corporation's position had been affected by their "obsolescent aircraft."

He went on to say that the final D.H. proposals for B.E.A.'s jet "only reached the Minister of Supply and myself this morning. . . . In the next few days we shall know how the Bristol and Hawker Siddeley company has got on in America . . . and we shall have a clearer knowledge of the basis on which the de Havilland offer is made."

He said his department was in consultation with architects for a new long-haul building at L.A.P. Central [this is the first official intimation that the Millbourn recommendations have been accepted].

British manufacturers are traditionally wary of publishing target-dates. Not so Vickers: here, unequivocally stated, is the flight development programme for the Vanguard, first flight of which is scheduled for mid-October of this year. Vickers say that design is now about 90 per cent complete; some 29,000 drawings have been issued out of a total of 32,000. On the production side, jig and tool design is now 100 per cent complete, and the manufacture of the first set of production tools is about 85 per cent complete.

CIVIL AVIATION . . .

QUID PRO QUO

INTERNATIONAL air transport provides few examples outside the U.S. of individual states licensing two national airlines to compete for the same traffic. And since Imperial Airways and British Airways did battle on the London - Paris route, nothing such as last week's agreement between the two British Corporations has been seen in the U.K. Although final details of this agreement have not yet been decided, in broad outline it appears that, subject to prevailing traffic rights, B.O.A.C. can operate through (not apparently "to") any point in Europe, in return for which B.E.A. can spread south-eastwards into the Middle East. Revenue will be pooled on most of those routes flown by both Corporations.

Although B.E.A. apparently regard the Middle East as being "outside its own territory," the sphere of B.E.A.'s influence was not defined at the time of the Corporation's inception in terms more precise than the Corporation's title. Indeed, when in 1950 B.O.A.C. first voiced its desire to serve points in Europe, B.E.A. replied that its price would be permission to serve North America!

Terms of the new agreement permit B.O.A.C. to compete more effectively in carrying intercontinental traffic to and from the Continent, the major single category being passengers flying between North America and Europe. By having access to more points in Europe, B.O.A.C. will also be better placed to carry traffic between Europe and Asia or Africa, and later between Europe and South America.

At first sight, B.E.A. appears to have the worst of this deal. But B.O.A.C.'s frequency through European points will be limited to that of its intercontinental schedules, and most available capacity will in any case be earmarked for through-traffic. Any diversion of short-haul traffic from B.E.A. to B.O.A.C. must also be measured against the fact that one new passenger travelling from London to Bahrain compensates in passenger-mile terms for the loss of 16 passengers flying between London and Paris. Bearing in mind the complications of short-haul operations, a steady flow of medium-haul traffic is an attractive proposition.

B.E.A. is probably better placed to exploit the Middle East than B.O.A.C. By being concentrated over a narrower sales area, B.E.A. can sell itself more intensively in the Middle East than can its sister Corporation. The improving range and speed of B.E.A. aircraft permit a convenient eastward extension of its route network to include points in Central Europe and the Middle East. Furthermore, B.E.A.'s arrangements with Malta Airways and Cyprus Airways allow both Israel and the Arab countries to be served, whereas B.O.A.C. did not consider it expedient to serve Tel-Aviv.

This new pact is significant not only to the two Corporations. To implement this policy it will be necessary for bilateral agreements to cover the possibility of the British Government licensing more than one carrier on many routes. Such a development will be viewed with favour by the independent British airlines.

U.S. FUEL TAX TO GO UP?

THE financially hard-pressed U.S. airlines may well be feeling, like Hamlet, that "troubles come not as single spies . . ." now that the President has put before Congress proposals for sharp increases in aviation fuel taxes. These, no doubt, are with a view to ensuring that the airlines will contribute their share to the very heavy cost of modernizing the Federal airways system in accordance with the airlines' demands.

Congress is being asked to approve the tax on jet fuel of 3.5 cents per U.S. gallon, and to increase the present tax on Avgas from 2 cents to 3.5 cents. These measures would be followed by further increases in both taxes—spread over four years—up to 6.5 cents per gallon.

This move will intensify the strife between U.S. airlines and the Civil Aeronautics Board over the question of fare increases; already the Air Transport Association has done a quick sum to show that if only the first step in the proposed tax increase had been in effect last year, the industry's $25 million total profit would not only have been wiped out, but there would have been a deficit of $18 million. As for the future, A.T.A. estimate that these measures could cost the industry as much as $167 million by 1962.

Thus Congress has before it a proposal which, if implemented, will be further evidence of the U.S. Government's determination not only to resist the U.S. airlines' call for higher revenues to finance their new jets, but also to see that the industry pays a share of the improvements to the facilities which it requires.

In the meantime, Continental Air Lines and United Air Lines have filed petitions for "emergency" fare increases of 15 per cent and 17 per cent respectively.

DECCA DEPARTURE—FROM NEW YORK

THE American Airways Modernization Board has placed a contract with Bendix Pacific for the installation of a Decca Navigator chain in the New York Area. The Board has officially stated that Decca was chosen because it is the only system now in a state of operational readiness and which will allow navigation with pin-point accuracy.

The new chain, at least the fifth in the New World, is to go into operation by April 1; and all helicopters of New York Airways will be equipped with receivers and Flight Log for evaluation. Bendix Pacific are the American agents for Decca Navigator. Experiments in blind-flying and landing with helicopters carried out by Bell Helicopter Corporation and Bendix, using a mobile Decca chain based on Fort Worth, were described in *Flight* for May 10 last year.

AN ILL WIND

AUSTRALIA'S domestic carrier, T.A.A., by publishing within the first two weeks of this month a complete statistical survey of the previous year's operations and traffic, sets the airline industry a worthy example. But the results are rather discouraging.

Trans-Australia are still carrying many more first-class than tourist-class passengers. Last year's traffic reached 394 million passenger-miles, of which 370m were first-class and only 25m tourist-class. The background to this is worth explaining. Australian domestic air fares are among the world's lowest, and on the major routes first-class and tourist-class fares are set at about fivepence and fourpence per passenger-mile respectively. Tourist-class fares are available only on a few densely travelled routes, having been originally introduced by T.A.A.'s privately owned competitors such as Butler, Ansett and A.N.A. As long as safety conditions are satisfied, there is no barrier to the introduction of tourist-class fares on present one-fare routes. Tourist fares have not been extended further because the airlines concerned believe that traffic would not increase appreciably as a result. Until Ansett-A.N.A. feel confident of their competitive position they are unlikely to engage in a rate-war with T.A.A.

T.A.A.'s increase in passenger traffic in 1957 of only five per cent compares with seven per cent in 1956 and fifteen per cent in 1955. This slowing-down can hardly be attributed to passengers losing interest in the Viscount for T.A.A. has been doing well on routes operated in competition.

Freight traffic has fallen slightly from 10.0 to 9.8 million ton-miles. This is partly ascribed to the steady improvement in rail and road services.

A general fares increase of five per cent in November 1956 had a detrimental effect on air-traffic last year. Also the Australian economy suffered from low wool prices and the havoc of bush fires in the second half of 1957. An ill wind appears to be sweeping through the Australian domestic market.

Last week saw the year's first fall of snow at London Airport Central, where B.E.A.'s photographer recorded the occasion with this shot of a Sabena Convair 440, a B.E.A. Viscount 701, and a B.E.A. Heron. The Corporation's photographic team does a fine job capturing the different moods of L.A.P.—as the striking picture reproduced across pages 58 and 59 of our January 10 issue testified.

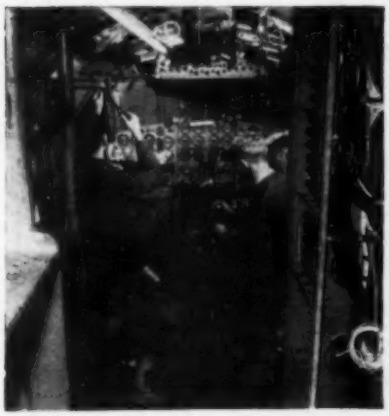
COMET 4 FINAL ASSEMBLY

FROM the two big de Havilland aircraft production facilities at Hatfield and Chester come these pictures of Comet 4 and 4B progress. A fleet of 19 Comet 4s is being built for B.O.A.C., and six Comet 4Bs for B.E.A. The first B.O.A.C. Comet 4 is due to fly at Hatfield in April, and will be delivered to the Corporation—with C. of A.—"in the autumn." This quick flight-test programme is a measure of the usefulness of three-and-a-half years of Comet 3 development work. Delivery of B.E.A.'s 4Bs will begin at the end of 1959, by which time all B.O.A.C.'s 4s should be in service.

In two or three years' time, perhaps, these factories will be filled with D.H.121s.

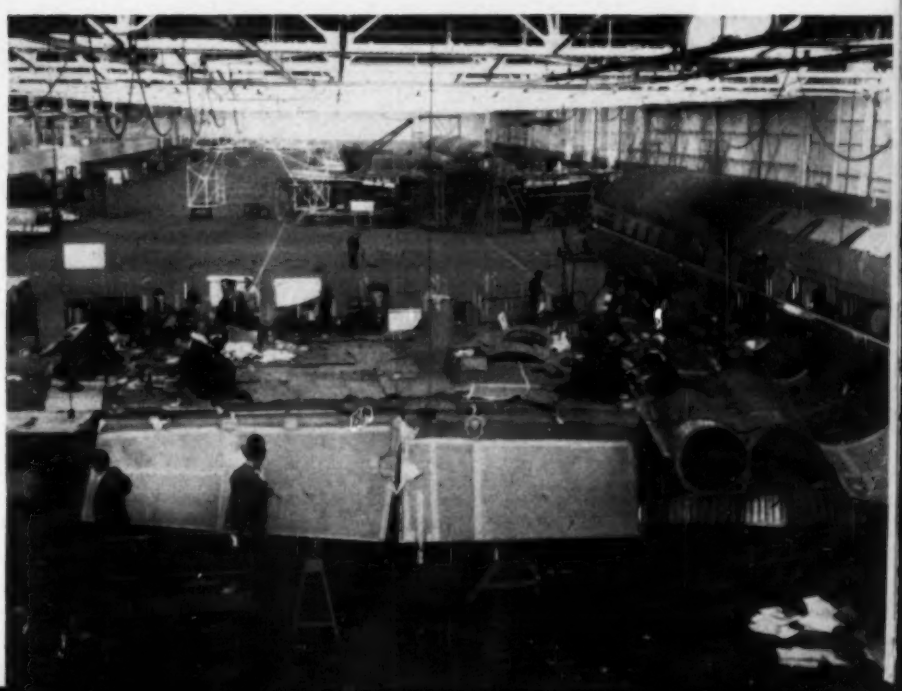
At D. H. Chester, one of Europe's biggest aircraft factories (1m sq ft), B.O.A.C. Comet 4 production is shared with Hatfield. A production rate at each factory of two Comets per month will be possible.

The third set of Comet 4 stub-wings, complete with centre-section, is prepared (right) for attachment of the extension wings. Meanwhile, the appropriate fuselage is being fitted out in another department.



(Above) At work in the first Comet 4 flight deck, where the grey instrument panels—changed from black in accordance with the modern trend—give a new look to the Comet cockpit. The Smiths Flight System and S.E.P.2 autopilot are seen to be in place.

(Right) First two Comet 4s at Hatfield. Here will be built B.E.A.'s six Comet 4Bs, whose 7ft shorter-span wing is soon to be flight-tested by the Comet 3, which is having its wings modified for this purpose.



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BRITISH EUROPEAN AIRWAYS AND VTOL (continued from page 138)

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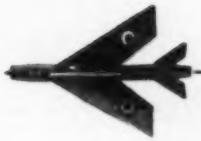

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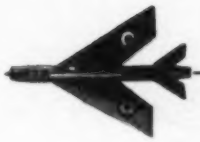

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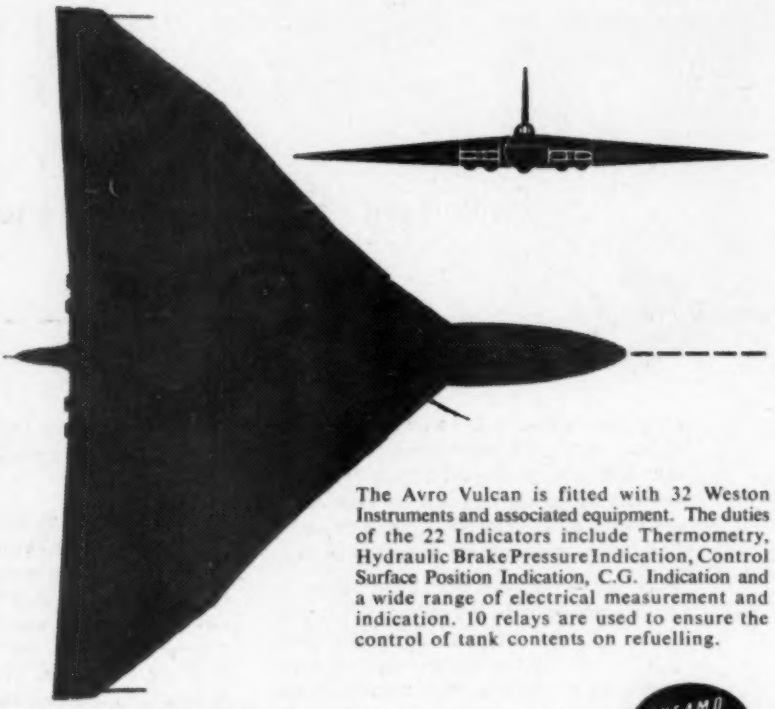

The Avro Vulcan is fitted with 32 Weston Instruments and associated equipment. The duties of the 22 Indicators include Thermometry, Hydraulic Brake Pressure Indication, Control Surface Position Indication, C.G. Indication and a wide range of electrical measurement and indication. 10 relays are used to ensure the control of tank contents on refuelling.

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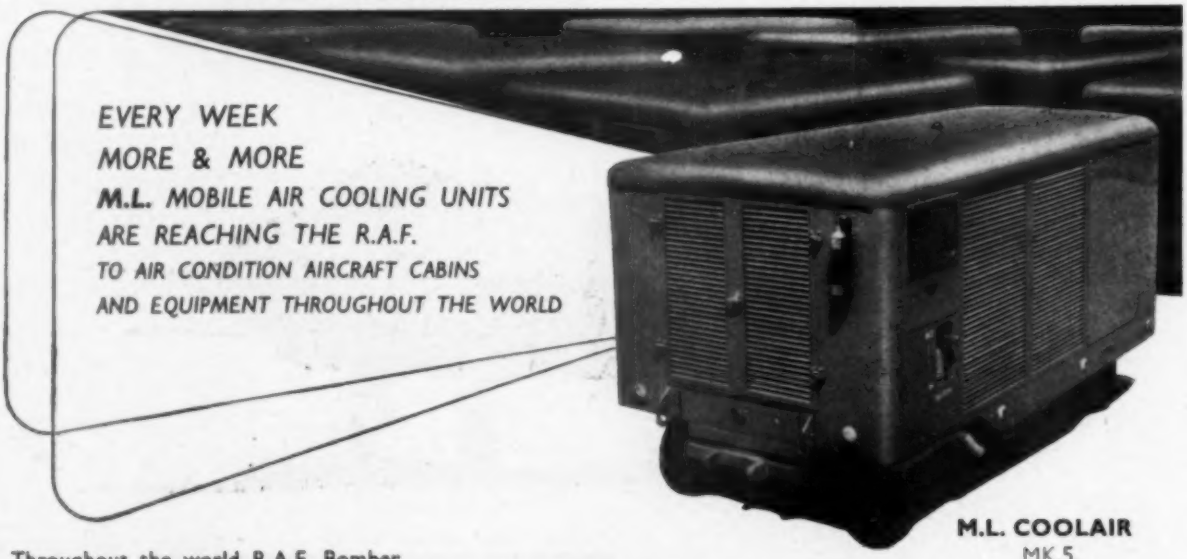

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The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns. The names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

The Government's Aviation Policy

MR. BESWICK'S article in your issue of January 10, like the rest of the advice which is being freely offered to the Government and the aircraft industry, makes some suggestions as to organization without touching the true issue of what this country's aviation policy ought to be.

This policy could be contained in the answers to these three questions:—

(1) What is to be the size and nature of the Government's research programme?
(2) What is the Government going to order in the military, and what is it going to sponsor in the civil, fields?
(3) What commercial conditions will it lay down for the placing of military orders and of those civil orders in which it is interested?

It is possible that none of these questions can yet be answered. But if they cannot, then it is vain to talk about aviation policy. Proposals for mergers, amalgamations, rationalization, nationalization, semi-nationalization, and so on are, in the absence of such a statement of policy, irrelevant and indeed mischief-making.

Oxhey, Herts. RICHARD COLLARD.

Armageddon—or ?

YOUR astonishingly apt quotation (in your editorial of January 17) from H. G. Wells' prophecy in May 1914 of atomic-bomb warfare has added to a belief of mine that the best prophets of the technical future are non-technical men, for it seems to me that engineers must err on the side of caution. But, before the engineers overwhelm me with their scorn of the layman, may I quote another prophecy, written nearly 100 years ago?

On March 9, 1862, during the American Civil War, the *Monitor* with its revolving gun turret protected with 8in of iron, defeated the *Merrimac* in the Hampton Roads and caused a sensation among the navies of the world. Henry Adams, grandson of the sixth President of the U.S.A., was then secretary to his father Charles Adams, the American Minister at the Court of St. James, and he wrote to his brother, who was serving in the Civil War, as follows:—

"Only a fortnight ago, they (the British) discovered that their whole wooden navy was useless. . . . Our good country, the United States, is left to a career that is positively unlimited except by the powers of the imagination. And for England there is still greatness and safety, if she will draw her colonies around her, and turn her hegemony into a confederation of British nations.

"You may think all this is nonsense, but I tell you these are great times. Man has mounted science, and is now run away with. I firmly believe that before many centuries more, science will be the master of man. The engines he will have invented will be beyond his control. Some day science may have the existence of mankind in its power, and the human race commit suicide by blowing up the world. Not only shall we be able to cruise in space, but I see no reason why some future generation wouldn't give it another rotatory motion so that every zone would receive in turn its due portion of heat and light."

Perhaps, sir, you might like to add here the first sentence of the last paragraph of your editorial? (i.e., "It *could* happen; but whether by means of America's colossal rearmament or of the proposed summit talks is not for this journal to suggest.").

Preston Park, Sussex. J. LAURENCE PRITCHARD.

Salesmanship Begins at Home

YOUR Special Correspondent, in his article "First Things First" (January 17), rightly emphasizes that, reorganization or no, the aircraft industry still has to sell its products in overseas markets.

But there is another, just as vital, job of selling which the industry ought to tackle as soon as possible: it must sell itself to the British public in general and to the Government in particular. The industry has not, one feels, presented its own case to the public vigorously enough. It must do more to win the public's confidence and admiration, to persuade the taxpayer that it is a first-class national asset worth every penny of the public money spent on it, and that it does not merely soak up money but earns it as well.

The Farnborough show is an excellent stimulant to public interest, but it alone is not really enough; to sustain that interest and to increase it, the possibilities of television or the cinema could be employed. A film dealing with the industry's achievements that equalled or surpassed in merit Shell's magnificent *Song of the Clouds* could do wonders in restoring the prestige which the industry has forfeited in recent months, and by presenting the basic facts of the industry's life (of which Ministers of the Crown, as well as the public, are not as well informed as they should be) would do a great service.

This is only one possibility, and whatever line of attack is chosen for this problem, it will cost money. But the more confidence and admiration the industry can command at home, the better will its chances be in selling its products overseas. And the more the industry's achievements—in producing and selling, as well as designing and making prototypes—are widely known and appreciated, the less is this or the next Government likely to try to reorganize, rationalize or nationalize the aircraft industry.

Rustington, Sussex. M. J. HARDY.

Monorail or Helicopter ?

IT appears that the M.T.C.A. are now giving favourable consideration to the building of a £7,000,000 monorail link between Victoria and London Airport to be operating by 1961.

For the same sum, the British helicopter industry could provide B.E.A. or the independent operators with sufficient helicopters by the same date to enable them to operate inter-city scheduled services, on an economic basis, throughout the length and breadth of the kingdom—taking the journey between London and London Airport in its stride.

These helicopter services would be able to operate in at least the same weather conditions that affect the fixed-wing airliners, so what is the point of taking passengers to the airport in the worst weather conditions, only to endure frustrating delays because their fixed-wing transport cannot take off.

Are we getting value for money?

Keston, Kent. BASIL ARKELL.

Society of Aircraft Historians an Urgent Need

THE letter from Mr. Gobby, in your issue of November 8, made me examine my conscience. As one who has decided views on aviation history, historic aircraft and their preservation, I was perturbed to realize that as far as action is concerned I have probably been as apathetic as anyone. I presume that your correspondent read A. Cdre. A. H. Wheeler's realistic letter, "The Cost of Keeping Veterans," in your issue of October 25, 1957; that did not confirm me in my apathy, but at least it convinced me that I alone could do very little towards ensuring the preservation of our veterans.

Mr. Gobby suggests that "the British aeronautical community" ought to launch an appeal for funds: that would be an admirable idea if that community existed as a cohesive, authoritative and articulate body. Unfortunately, it does not. True, there are several bodies whose activities include an interest in various aspects of aviation history; and there are others (notably the S.B.A.C.) whose activities *ought* to include such an interest. Generally speaking, organizations of the former sort have too little money to undertake much active work, and the latter are too busy looking ahead to spare a thought or a copper for the past.

A very great deal could and should be done, but it might be well for us to heed the Chinese proverb to the effect that even a journey of a thousand miles begins with but a single step. And the formation of an organization of the kind suggested by "Beltane" (*Flight*, December 6, 1957) could be an essential first step towards the achievement of what is in Mr. Gobby's mind and very near to the hearts of many of us. As "Beltane" points out, there is neither a meeting place nor an organization for those who care about our aviation history. The need could hardly be greater—it may be that we are witnesses of the gradual demise of the military aircraft, and sporting flying is being slowly stifled. The development of aircraft has occurred within the span of a man's lifetime. If we now fail to secure an authentic and adequate record of our nation's great contributions to aviation our generation will stand condemned in the eyes of future historians.

As Mr. Andrews has said (*Flight*, January 10, 1958), much research and interchange of valuable information has been going on between interested people for some years. The results of that informal and unregulated work have proved fruitful and constructive, and a serious historical society, intelligently run, might be the ideal means of extending and consolidating the field of knowledge and of compiling records of that knowledge. (In his letter, Mr. Andrews makes some extremely kind remarks, but it is no desire merely to return a compliment that prompts me to say that any historical society which did not include his own name would fall short of success.) It is true, as he says, that there are already "many societies, forums, clubs and so on," but I know of none in Britain which devotes more than a small part of its activity to aviation history. Moreover, such organizations usually include in their membership an alarming number of people who pursue useless information with that brand of fanaticism which compels

CORRESPONDENCE . . .

small boys to collect the numbers of railway locomotives.

Such a society as that envisaged by "Beltane" could also be the important nucleus of further development, the more so if it could command (as indeed it should) recognition by and the support of such bodies as the S.B.A.C., Royal Aeronautical Society, Royal Aero Club and the Air League. For none will deny the clamant need for a British national aeronautical museum, which ideally would house all surviving veteran aircraft and provide facilities for flying the airworthy ones and maintaining them all; it would also have a collection of photographs and aeronautica, and would afford a meeting place for all who are interested in our aviation history.

I know that this is not a new idea; I know that earlier attempts to get somewhere with it have failed; I know that it would cost a lot of money both to establish and to maintain; but I remain convinced that it could be achieved if sufficient interest, goodwill and support were forthcoming from the right quarters. A body of the kind proposed by "Beltane" could, I think, do much useful groundwork with this end in view, and I am wholeheartedly in favour of its early establishment.

An aviation historical society would not require premises, but it would have to have the occasional use of some kind of accommodation. It would also need a journal, or at least some space in an established publication, not only for its domestic business but for the recording of the history which would be the essential reason for its existence. Above all, it would need funds and the intelligent support of the aircraft industry—which might have belonged almost entirely to the late Henry Ford for all the interest it has shown in its own history.

Time is not on our side: the sounding of the distress signal so aptly implicit in "Beltane's" *nom de guerre* could hardly be more opportune—or more urgent.

Birmingham, 32. J. M. BRUCE.

What the Stars Foretell

I AM a little hurt that "Expectant" (*Flight*, January 17) should suggest that my predictions for 1958 might not be entirely accurate. He has, I see, had to refer to his diary to confirm that Christmas Day will fall on a Thursday this year. Now, surely, that is proof enough of the accuracy of my predictions? Admittedly these forecasts were provided with the aid of an astrologer's glass Mk 1 which, as "Expectant" will know, is not fitted with any precise method of target identification and this may mean that some of my readings will be a few weeks out. But really, Christmas Day stands out quite clearly even in a dusty Mk 1. And "Expectant" will, if he reads his daily newspaper, see that another of my predictions has come true—several daily newspapers said on January 17 that Fighter Command is *not* to be abolished. I predicted that weeks ago!

London, W.C.2. (Miss) CRYSTAL BALL.

The Britannia in Service

I FEEL I must commiserate with Ken Warren (Correspondence, January 10) in his view that "statistics are usually gloomy things." One man's meat is, of course, another man's *poisson*, but his basic trouble must surely be an unusually gloomy statistical upbringing. Has he ceased to spare a thought for the more vital variety? I sincerely hope not.

Seriously, however, would it be right for manufacturers to turn statistics upside down and look on the happy side? Surely not. It is the nigger in the woodpile that is important, not the woodpile.

On delay statistics I agree with him entirely, but this leads on to a topical problem on the North Atlantic operations. Should an operator publish a relatively generous trip time coupled with a high probability of arriving on schedule, or a tight schedule to attract business but which carries a high but hidden probability of late arrival? An operator has only to reduce the scheduled trip time to attract the intending passenger (who is usually ignorant of the associated lower probability of arriving on schedule).

Windsor, Berks. C. JOHN BARRON.

Turbulent Under Control

AS one of a group who watched the first flights of Mr. Norman Jones' Turbulent from the opposite side of the airport to your reporter, I should like to question his implied condemnation (*Flight*, January 10) of the Croydon controllers on that occasion.

In our opinion Mr. Jones *did* fly unwisely, not in making runs in proximity to other aircraft, but in having an insufficient height margin when flying over houses near the aerodrome. After all, these were the first flights of a newly built aircraft—powered only by a 30 h.p. modified car engine. Let's be fair and not swipe at the controllers without first having a good reason.

Croydon. CROYDON PILOT.

[Our staff writer who reported this occasion writes: "Most regular users of Croydon, including *Flight*, are well aware of the helpful attitude displayed on many occasions by tower controllers there. No unfair condemnation was intended. On this occasion *Flight* reported the facts that a controller had said there had been dangerous flying, and that a group of experienced pilots watching had said there had *not* been dangerous flying. Certainly it is possible that the controller was right, but surely the red Very light that was fired as Mr. Jones approached for a pass (and as a Chipmunk was completing its landing run) had nothing to do with altitude over houses."—Ed.]

Restrictions on the Private Pilot

YOUR correspondent M. J. Conry (January 17) is right. What has any airline pilot got to carp about when he's sitting between four big engines and stewardesses?

Come to think of it, what has old Conry got to carp about if he can get to Wick and back on eight quid and see 2,000 yd in a fog?

He must be a child prodigy.

London, S.W.3. HAMISH WOOLY.

Sopwith Schneider and Baby

I WAS very interested in Mr. C. H. Chichester-Smith's letter on the Sopwith Schneider Baby. I must confess I was surprised at his reference to the Monosoupape engine. We had some of these machines at South Shields Naval Air Station and I possess a photograph of one on the slipway there in 1917. They were fitted with the Clerget engine, which also could be started by a handle in the cockpit. When operating from a slipway, of course, the engine was started by "swinging the prop." A man in waders stood in the water up to his thighs in front of the machine and scrambled out of the way as soon as the engine started.

Gosselies, Belgium. VICTOR R. GODFREY.

[Our correspondent is confusing the Baby with the Schneider, which was the type mentioned by Mr. Chichester Smith. As recorded by J. M. Bruce in his recent series of articles on "The Sopwith Tabloid, Schneider and Baby," the Schneider had the 100 h.p. Gnôme Monosoupape and the Baby (variously) the 110 h.p. or 130 h.p. Clerget. Mr. Bruce remarked in Pt. 3 of his article (November 22, 1957) that "The modified aircraft became known as the Sopwith Baby, but the name Schneider persisted and was occasionally used to describe both Schneiders and Babies. Naturally, these loose identifications have led to some confusion over the precise identity of the type concerned in various exploits"—Ed.]

FORTHCOMING EVENTS

Feb. 1. British Interplanetary Society: "Meteoric Hazards to Space Flight," by Dr. N. H. Langton.
Feb. 4. Kronfeld Club: Talk on B.G.A. gliding courses.
Feb. 5. Kronfeld Club: "The Oxygen Story," by G. Melvill-Jones.
Feb. 7. Helicopter Association: "Wind Tunnel Testing of Helicopter Models," by M. S. Hooper.
Feb. 7. A.B.A.C.: Annual Dinner.
Feb. 10. Institute of Transport: Brancker Memorial Lecture: "Problems and Economics of Air Traffic," by A. Cdre. W. E. G. Mann.
Feb. 12. Kronfeld Club: "Flying and Motor Racing," by R. Flockhart.
Feb. 13. R.Ae.S.: Main Lecture: "Application of the Theory of Stability in Structural Design," by H. L. Cox.
Feb. 14. Plymouth Aero Club: Dinner Dance.
Feb. 18. R.Ae.S.: Section Lecture: "Aeroelastic Problems at High Speeds and High Temperature," by E. G. Broadbent.
Feb. 19. Royal Meteorological Society: Discussion: "Meteorological Aspects of Rockets and Satellites."
Feb. 19. Kronfeld Club: "North Wales, The Soaring Pilot's Paradise," by W. Crease.
Feb. 20. R.Ae.S.: Main Lecture, at Halton: First Trenchard Memorial Lecture, by Air Chief Marshal Sir Dermot Boyle.
Feb. 25. R.Ae.S.: Guided Flight Section: "Guided Flight Trials," by R. W. Beswell.
Feb. 26. R.Ae.S.: Presidential Address by Sir George Edwards.

R.Ae.S. Branch Fixtures (to Feb. 27):—
Jan. 31, *Chester*, Annual Dance. Feb. 3, *Derby*, A.G.M.; *Henlow*, A.G.M. Feb. 4, *Glasgow*, "Recent Progress in Turbojets, and Its Effect on Aircraft Design," by J. L. Edwards; *Luton*, "Development of the Armstrong Siddeley Viper," by W. H. Lindsey. Feb. 5, *Brough*, "Supersonic Aircraft and Missiles," by P. J. Duncton; *London Airport*, "Noise," by Prof. E. J. Richards; *Reading*, "Ultra-Sonic Testing," by J. Crowther. Feb. 6, *Bristol*, "Design of Civil Aircraft," by D. P. Thorne; *Isle of Wight*, "Development of the Rotodyne and Gyrodyne," by D. M. Davies; *Swindon*, Lectures. Feb. 11, *Boscombe Down*, Film Show. Feb. 12, *Chester*, "Aircraft Fuelling Problems," by E. L. Bass. Feb. 13, *Bristol*, "Production of Civil Aircraft," by Mr. Imlach; *Cheltenham*, "The Microscope in Engineering," by A. E. Bingham. Feb. 17, *Henlow*, Junior Members Lecture Competition. Feb. 19, *Christchurch*, "Aircraft Carriers," by A. J. Simms; *Leicester*, "Activities of the Production Engineering Assoc.," by R. Tilsley; *Southampton*, Branch Prize Papers. Feb. 20, *Bristol*, "Sale of Civil Aircraft," by R. White-Smith; *Cambridge*, Lecture by H. Povey; *Halton*, Main Lecture (see above); *Isle of Wight*, "Modern Methods of Air-Sea Rescue," by Lt-Cdr. J. S. Sproule. Feb. 21, *Birmingham*, Branch President's Night. Feb. 26, *Hatfield*, "Fairey Delta 2," by R. L. Lickley and L. P. Twiss; *Preston*, "Problems Associated with Non-Metallic Materials in Aircraft," by N. J. L. Megson and E. W. Russell. Feb. 27, *Bristol*, "Servicing of Civil Aircraft," by I. Gregory; *Cambridge*, "Some Aspects of Aircraft Production," by H. Povey; *Yeovil*, Third Henson and Stringfellow Memorial Lecture, by S. G. Hooker.

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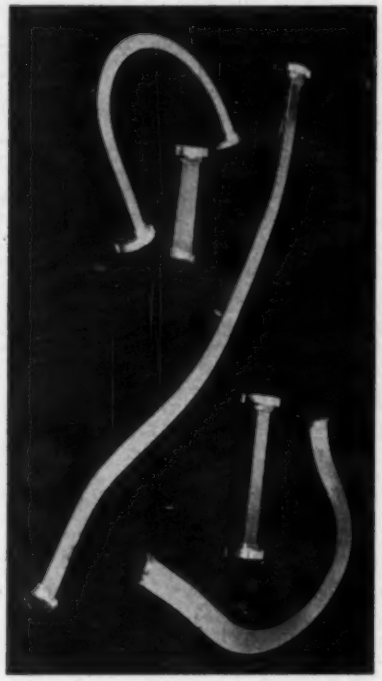
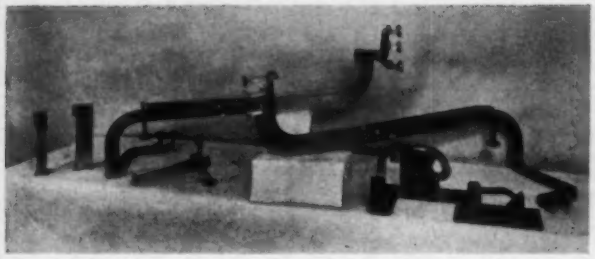


Left: Typical Radar Waveguides assemblies as fitted to the ***AVRO VULCAN***



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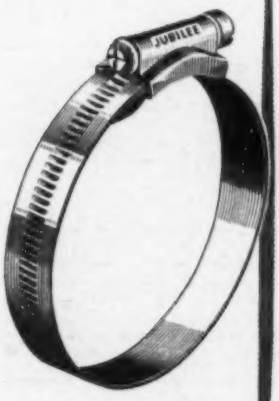

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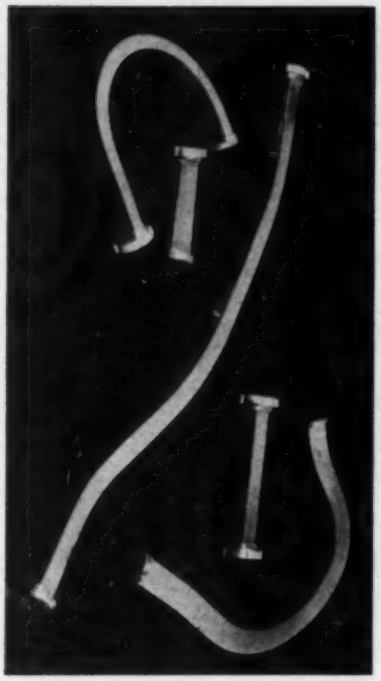

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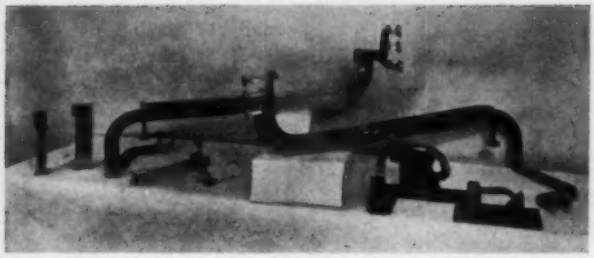

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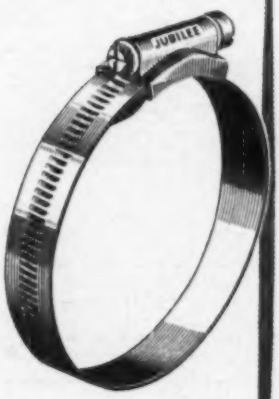

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THE AIR TRANSPORT ADVISORY COUNCIL give notice that they had received the undermentioned applications to operate scheduled air services:—

FROM Derby Aviation, Ltd., of Derby Airport, Burnaston, Derby, for the following scheduled services to be operated initially with Marathon and Dakota aircraft and later with Herald aircraft for the carriage of passengers, supplementary freight and mail, from March to October inclusive each year except where otherwise stated, for seven years from March 1, 1958:—

APPLICATION No. 1604 for a U.K. Internal Service on the route Cambridge-Luton (opt.)-Bournemouth (Hurn) (tech.)-Jersey at an initial frequency of seven return flights weekly increasing later to 14 return flights weekly.

APPLICATION No. 1607 for a Normal Scheduled Service on the route Derby-Nottingham (opt.)-Birmingham-Bordeaux (tech.)-Biarritz at an initial frequency of one return flight weekly increasing later to three return flights weekly.

APPLICATION No. 1608 for a Normal Scheduled Service to be operated throughout the year on the route Derby-Nottingham (opt.)-Birmingham-Bordeaux (tech.)-Madrid (tech.)-Tangier at an initial frequency of one return flight weekly increasing later to two return flights weekly.

FROM British Overseas Airways Corporation of London Airport, Hounslow, Middlesex, for the following amendments to Normal Scheduled Services operated on reserved routes set out in Schedule "A," Part I, to the Terms of Reference issued to the Council by the Minister of Civil Aviation on July 30, 1952, and on other approved routes:—

APPLICATION No. 1609 for permission to terminate services at Kuala Lumpur on Reserved Routes Nos. 4 and 5.

APPLICATION No. 1610 for permission to include optional traffic stops at Istanbul and/or Teheran on Reserved Routes Nos. 1, 2, 3, 4, 5 and 6 and on the route approved under Application No. 339 (London-Abadan and/or Karachi).

APPLICATION No. 1611 for permission to include an optional traffic stop at Benghazi on Reserved Routes Nos. 11, 12 and 13 and on the routes approved under Applications Nos. 57 (London-Dar es Salaam), 62 (London-Lusaka and/or Salisbury) and 360 (London-Nairobi).

APPLICATION No. 1612 for permission to include an optional traffic stop at Frankfurt on Reserved Route No. 14.

APPLICATION No. 4/8 from East Anglian Flying Services, Ltd., of Southend Airport, Essex, for an amendment to the terms of approval of the U.K. Internal Service which they are authorised to operate with DH.89, Consul, Anson, Dakota, Heron, Dove and Bristol 170 aircraft on the route Ipswich-Southend-Rochester-Shoreham-Alderney-Guernsey-Jersey at a frequency of 36 return flights weekly (with a maximum capacity of 1,280 seats in each direction) from June to September inclusive and 30 return flights weekly (with a maximum capacity of 1,080 seats in each direction) at other times, so as now to enable them to operate at a frequency in accordance with traffic demand.

THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on July 30, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3 Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [7525

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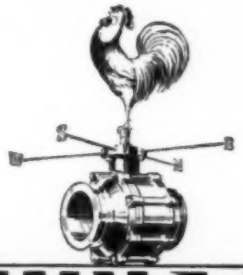

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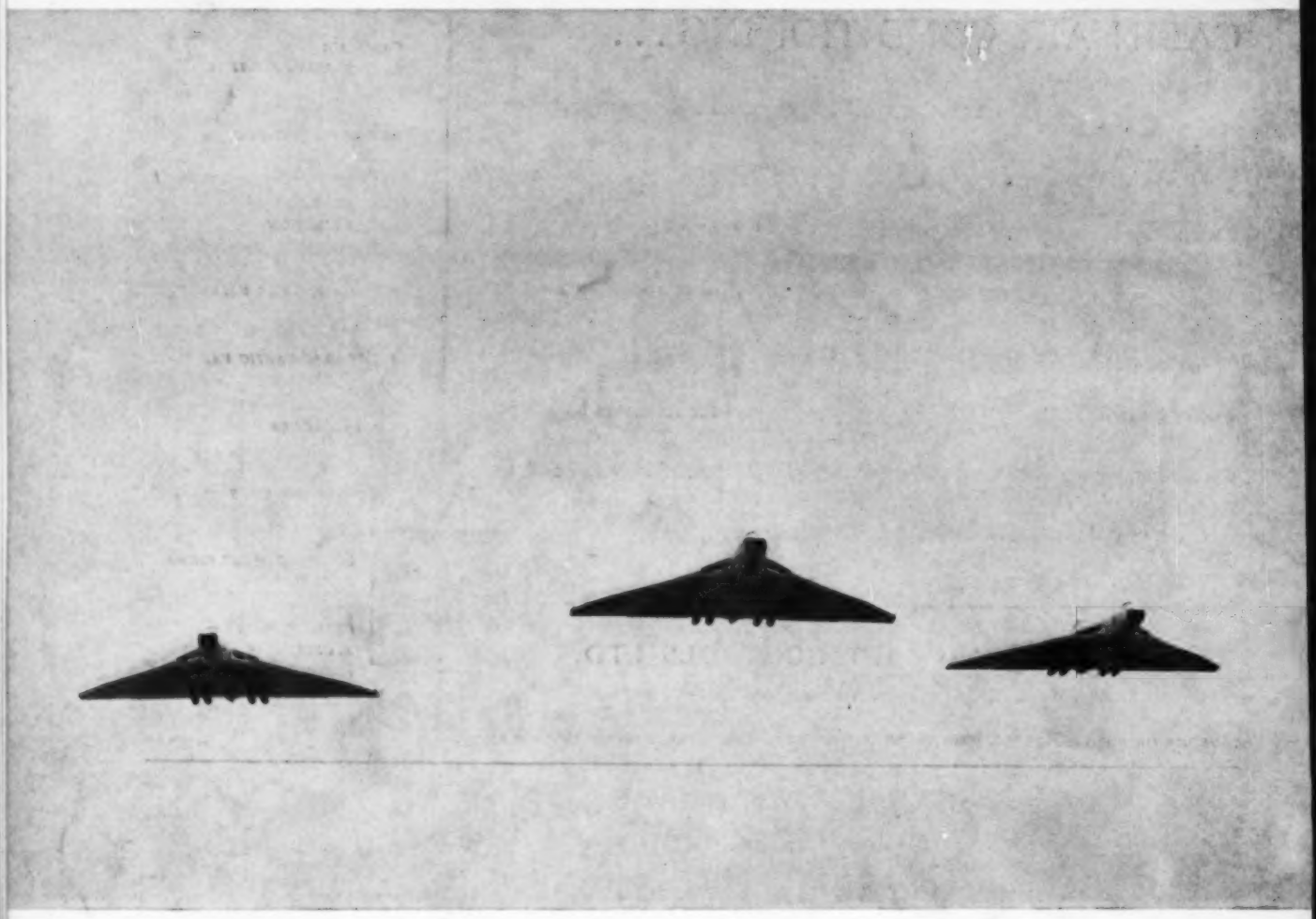

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